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HYDRAULICS LABORATORY

TECHNICAL REPORT HL-89-26

A NUMERICAL MODEL STUDY OF THE EFFECT OF CHANNEL DEEPENING ON SHOALING AND SALINITY INTRUSION IN THE SAVANNAH ESTUARY

by

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DTIC

December 1989
Final Report

Approved For Public Release; Distribution Unlimited

Prepared for US Army Engineer District, Savannah
Savannah, Georgia 31402-0889

90 01 17 095

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Technical Report HL-89-26	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION USAEWES Hydraulics Laboratory 6b. OFFICE SYMBOL (If applicable) CEWES-HR-M	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) 3909 Halls Ferry Road Vicksburg, MS 39180-6199	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION USAED, Savannah 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) PO Box 889 Savannah, GA 31402-0889	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
A Numerical Model Study of the Effect of Channel Deepening on Shoaling and Salinity Intrusion in the Savannah Estuary

12. PERSONAL AUTHOR(S)
Johnson, B. H.; Trawle, M. J.; Kee, P. G.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final report	FROM ____ TO ____	December 1989	300

16. SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Estuary	Numerical model
			Hydrodynamics	Salinity intrusion
			Laterally averaged	Sediment transport

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A numerical laterally averaged estuary model called LAEM has been modified to handle sediment along with flow, temperature, and salinity computations. A bed model that allows for multiple layers when the sediment is cohesive has been incorporated to simulate the exchange of sediment between the bed and the water column. The resulting model, called LAEMSED, is a useful tool in assessing the impact of changes in channel geometry on salinity intrusion and shoaling in either a single channel or a multiple-connected system of channels.

Results from a study in the Savannah Estuary show good agreement with 1985 field data on tides, velocities, and salinities. In addition, good agreement with shoaling rates estimated from dredging records was obtained. Results from applications of the verified model to assess the impact on salinity intrusion and shoaling of deepening the

(Continued)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

DD Form 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. ABSTRACT (Continued).

navigation channel by 3 and 6 ft are presented. General conclusions are that deepening the navigation channel as much as 6 ft moves the primary shoaling region upstream about 10 miles to the river reach containing the Kings Island Turning Basin with an overall increase in shoaling volume of about 14 percent. For the same increase in depth, salinities along Front River will increase by a maximum of 2-4 ppt, depending upon tidal and freshwater inflow conditions, whereas the maximum increase in salinity near the wildlife refuge on Little Back River will be less than 1.0 ppt.

PREFACE

The work described herein and the preparation of this report were conducted from January 1985 to May 1989 for the US Army Engineer District, Savannah, by the US Army Engineer Waterways Experiment Station (WES) under the general supervision of Mr. F. A. Herrmann, Jr., Chief of the Hydraulics Laboratory, Mr. M. B. Boyd, Chief of the Waterways Division (WD), and Mr. W. H. McAnally, Chief of the Estuaries Division (ED).

Dr. B. H. Johnson and Mr. M. J. Trawle, Math Modeling Group, WD, and Ms. P. G. Kee, Estuarine Engineering Branch, ED, conducted the study and prepared this report. Mr. H. A. Benson, Estuarine Processes Branch, ED, supervised the field data collection program. This report was edited by Mrs. Marsha C. Gay, Information Technology Laboratory, WES.

Acting Commander and Director of WES during preparation of this report was LTC Jack R. Stephens, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
cubic yards	0.7645549	cubic metres
feet	0.3048	metres
miles (US statute)	1.609344	kilometres

A NUMERICAL MODEL STUDY OF THE EFFECT OF CHANNEL DEEPENING ON SHOALING AND SALINITY INTRUSION IN THE SAVANNAH ESTUARY

PART I: INTRODUCTION

Background

1. The Savannah Estuary extends from the Atlantic Ocean to the northwest, dividing the states of Georgia and South Carolina. It consists of a series of channels and loops, all interconnected, with the main navigation channel following North Channel and along Front River (Figure 1). Located on Little Back River is the Savannah National Wildlife Refuge. A tide gate and a sediment trap are located on Back River (Figure 1). During flood phase the tide gate is open, and a good portion of the sediment that deposited along the North Channel during the previous slack is resuspended and carried into the sediment trap where it is redeposited. During ebb phase the tide gate is closed. The closed gate forces all ebb flow through Front River, thereby increasing velocities and causing resuspension and flushing of slack-deposited sediment from the Front River channel. The overall result is reduced maintenance dredging along the Front River channel. Tidal influence extends from the mouth upstream approximately 45 miles* to Ebeneezer Landing.

2. One of the factors being considered in the Savannah Harbor Comprehensive Study by the US Army Engineer District, Savannah, is an evaluation of the impact of proposed channel deepening on salinity intrusion and shoaling along Front River. To address this question, the Savannah District requested that the Hydraulics Laboratory, US Army Engineer Waterways Experiment Station (WES), conduct a numerical modeling study.

Approach

3. In a recent study at WES, an existing laterally averaged hydrodynamic model, which includes salinity and its coupling with the flow through the water density, was applied on the Lower Mississippi River to evaluate the

* A table of factors for converting non-SI units of measurement to metric (SI) units is found on page 4.

impact on salinity intrusion of deepening the navigation channel from 40 to 55 ft (Johnson, Boyd, and Keulegan 1987). The model applied is called LAEM (Laterally Averaged Estuary Model) and was developed by Edinger and Buchak (1981). Due to the success realized in the Lower Mississippi study, it was decided to apply a branched version of LAEM on the Savannah Estuary system. The branched version is required due to the complex hydrodynamic nature of the Savannah Estuary, which includes both branches and closed loops.

4. To address the shoaling problem, suspended sediment computations and a sediment bed model were required in LAEM. These additions constituted a major modification and were patterned after work by Thomas and McAnally (1985) in their development of a vertically averaged sediment transport model called STUDH. The resulting numerical model is called LAEMSED.

5. To provide historical data for model verification, WES conducted a field survey in April 1985. Tides, velocities, salinities, and suspended sediment concentrations were recorded at selected locations along the estuary. A separate set of rather limited data collected by WES in 1980 was also used. Sediment verification was based upon dredging records provided by the Savannah District. Geometry data required to schematize the system were taken from National Oceanic and Atmospheric Administration (NOAA) charts, dredging surveys, and a hydrographic survey conducted by the US Fish and Wildlife Service in 1986.

PART II: THEORETICAL ASPECTS OF LAEMSED

6. Under the Environmental and Water Quality Operational Studies (EWQOS) program of the US Army Corps of Engineers, developmental work was conducted on a two-dimensional (2-D), laterally averaged, free-surface, variable-density, and heat-conducting model for use in simulating flows in thermally stratified reservoirs. This effort, which extended the earlier work funded by the US Army Engineer Division, Ohio River (Edinger and Buchak 1979), resulted in a numerically efficient model that is known as LARM (Laterally Averaged Reservoir Model). Under a contract with the Savannah District, LARM was modified for use in computing stratified flows in estuaries as a result of both salinity and thermal effects. This model is known as LAEM (Edinger and Buchak 1981). As described in paragraph 3, an application of LAEM to a channel deepening study by Johnson, Boyd, and Keulegan (1987) on the Lower Mississippi River demonstrated the general applicability of LAEM to such problems. A version of LAEM that allows the modeling of innerconnecting channels has been modified for this study. This model, which computes suspended sediment transport and simulates the erosion/deposition process at the bed, is called LAEMSED.

Governing Flow-Transport Equations

7. The basic set of flow and transport equations that are solved in LAEMSED are statements of the conservation of mass and momentum of the flow field plus the conservation of the heat, salt, and suspended sediment in the water body. The governing equations are developed by first performing a temporal averaging of the three-dimensional equations for laminar flow. Boussinesq's eddy coefficient concept is then employed to account for the effect of turbulence in the flow field. Next, the time-averaged equations are averaged over the estuary width and finally over an individual vertical layer with boundaries at $z = k + 1/2$ and $z = k - 1/2$ to yield the following equations that are solved in the water column in LAEMSED. Variables are defined following Equation 9. Note that LAEMSED employs metric units.

a. Longitudinal (x-direction) momentum

$$\frac{\partial}{\partial t}(UBh) + \frac{\partial}{\partial x}(U^2Bh) + \left(u_b w_b b\right)_{k+1/2} - \left(u_b w_b b\right)_{k-1/2}$$

$$+ \frac{1}{\rho}\frac{\partial}{\partial x}(PBh) - A_x \frac{\partial^2}{\partial x^2}(UBh) + \left(\tau_z b\right)_{k+1/2} - \left(\tau_z b\right)_{k-1/2} = 0 \qquad (1)$$

with

$$\tau_z = \frac{C^*\rho_a}{\rho W_a^2} \cos\phi \quad \text{(surface)}$$

$$= A_z \left(\frac{\partial U}{\partial z}\right) \quad \text{(interlayer)}$$

$$= \frac{gU|U|}{C^2} \quad \text{(bottom)}$$

b. Internal continuity

$$\left(w_b b\right)_{k-1/2} = \left(w_b b\right)_{k+1/2} + \frac{\partial}{\partial x}(UBh) - \frac{q_1 Bh}{V} \qquad (2)$$

c. Total depth continuity

$$\frac{\partial(\xi b)}{\partial t} - \sum_k \frac{\partial}{\partial x}(UBh) = \frac{q_2 Bh}{V} + \sum_k \frac{q_1 Bh}{V} \qquad (3)$$

where q_2, which represents the discharge of water moving into or out of overbank storage, is computed from

$$q_2 = \frac{A_f \Delta\xi}{\Delta t} \qquad (4)$$

d. Vertical (Z-directional) momentum

$$\frac{\partial P}{\partial z} = \rho g \tag{5}$$

e. Heat balance

$$\frac{\partial}{\partial t}(BhT) + \frac{\partial}{\partial x}(UBhT) + \left(w_b bT\right)_{k+1/2} - \left(w_b bT\right)_{k-1/2}$$

$$- \frac{\partial}{\partial x}\left(D_x \frac{\partial BhT}{\partial x}\right) - \left(D_x \frac{\partial BT}{\partial z}\right)_{k+1/2} + \left(D_z \frac{\partial BT}{\partial z}\right)_{k-1/2} = \frac{H_n Bh}{V} \tag{6}$$

f. Salinity balance

$$\frac{\partial}{\partial t}(BhS) + \frac{\partial}{\partial x}(UBhS) + \left(w_b bS\right)_{k+1/2} - \left(w_b bS\right)_{k-1/2} - \frac{\partial}{\partial x}\left(D_x \frac{\partial BhS}{\partial x}\right)$$

$$- \left(D_z \frac{\partial BS}{\partial z}\right)_{k+1/2} + \left(D_z \frac{\partial BS}{\partial z}\right)_{k-1/2} = \frac{(Sq_1 + S_{KT}q_2)\ Bh}{V} \tag{7}$$

g. Suspended sediment balance

$$\frac{\partial}{\partial t}(BhC_s) + \frac{\partial}{\partial x}(UBhC_s) + \left(w_b bC_s\right)_{k+1/2} - \left(w_b bC_s\right)_{k-1/2} - \frac{\partial}{\partial x}\left(D_x \frac{\partial BhC_s}{\partial x}\right)$$

$$- \left(D_z \frac{\partial BC_s}{\partial z}\right)_{k+1/2} + \left(D_z \frac{\partial BC_s}{\partial z}\right)_{k-1/2} = H_s Bh + \frac{C_s q_2 Bh}{V} \tag{8}$$

h. Equation of state

$$\rho = \frac{1{,}000\ P_o}{LA + 0.698\ P_o} + \frac{(\gamma_s - 1)}{\gamma_s} C_s \tag{9}$$

where

$P_o = 5{,}890 + 38T - 0.375T^2 + 3S$

$LA = 1{,}779.5 + 11.25T - 0.0745T^2 - (3.8 + 0.01T)S$

Variables and units in Equations 1-10 are defined as follows:

A_f = plan area of overbank storage, m^2

A_x = x-direction momentum dispersion coefficient, m^2/sec

A_z = z-direction momentum dispersion coefficient, m^2/sec

b = estuary or river width, m

B = laterally averaged width integrated over h, m

C = Chezy resistance coefficient, $m^{1/2}$/sec

C^* = resistance coefficient associated with wind

C_s = suspended sediment concentration, kg/m^3

D_x = x-direction temperature, salinity, and suspended sediment dispersion coefficient, m^2/sec

D_z = z-direction temperature, salinity, and suspended sediment dispersion coefficient, m^2/sec

g = acceleration due to gravity, m/sec^2

h = horizontal layer thickness, m

H_n = source strength for heat balance, °C-m^3/sec

H_s = sediment source, kg/m^3/sec

k = integer layer number, positive downward

P = pressure, N/m^2

q_1 = tributary inflow or withdrawal, m^3/sec

q_2 = exchange of flow between channel and overbank, m^3/sec

S = laterally averaged salinity integrated over h, ppt

S_{KT} = laterally averaged salinity in top layer, ppt

t = time, sec

T = laterally averaged temperature integrated over h, °C

u_b = x-direction, laterally averaged velocity, m/sec

U = x-direction, laterally averaged velocity integrated over h, m/sec

V = cell volume $(B \cdot h \cdot \Delta x)$, m^3

W_a = wind speed, m/sec

w_b = z-direction laterally averaged velocity, m/sec

x and z = Cartesian coordinates: x is along the estuary center line at the water surface, positive to the right, and z is positive downward from the x-axis, m

Δt = time-step, sec

Δx = longitudinal spatial step, m

$\Delta \xi$ = change in surface elevation, m

γ_s = specific gravity of sediment

ξ = surface elevation, m

ρ = density, kg/m^3

ρ_a = air density, kg/m^3

τ_z = water density times tangential stress in positive x-direction, m^2/sec^2

ϕ = wind direction, rad

8. Basic assumptions in addition to the reduced dimensionality are that the Boussinesq approximation (ρ is constant except where multiplied by the acceleration of gravity) is applicable and that vertical accelerations are negligible so that the pressure can be considered hydrostatic. In addition, the concept of eddy coefficients is used to represent the effect of both time averaging, as previously noted, and spatial averaging of the equations. The horizontal dispersion coefficients, A_x and D_x, are assumed to be constant, whereas the vertical dispersion coefficients, A_z and D_z, are dependent upon the stratification as reflected by the local Richardson number, R_i, i.e.

$$A_z = A_{z_o}(1 + 3.33R_i)^{-3/2} \tag{10}$$

$$D_z = D_{z_o}(1 + 10R_i)^{-1/2} \tag{11}$$

where

$$R_i = \frac{\frac{g}{\rho}\frac{\partial \rho}{\partial z}}{\left(\frac{\partial U}{\partial z}\right)^2}$$

and A_{z_o} and D_{z_o} are the vertical coefficients for no stratification. Due to the hydrostatic pressure assumption, unstable stratification cannot be modeled in a convective fashion and thus is handled in a diffusive manner by increasing D_z to its stability limit of $h^2/2\Delta t$, where Δt is the computation time-step.

9. The laterally averaged horizontal pressure gradient in the longitudinal momentum equation contains the density driving force. Using the expression for the hydrostatic pressure, the horizontal pressure gradient can be divided into its two components of the barotropic (surface slope) gradient and the baroclinic (density) gradient to yield

$$\frac{\partial P}{\partial x} = -g\rho\frac{\partial \xi}{\partial x} + g \int_{\xi}^{z} \frac{\partial \rho}{\partial x}\, dz \tag{12}$$

Numerical Solution Scheme

10. Finite difference techniques are employed to solve the governing equations. The particular scheme employed is structured such that the water-surface elevations are computed implicitly. Using the new water-surface elevations, the x-component of the flow velocity is then explicitly computed from the longitudinal momentum equation. As in other hydrostatic models, the vertical component of the velocity is computed from the continuity equation, which is reduced to the incompressibility condition as a result of the Boussinesq approximation. The solution begins at the bottom and progresses up the column of layers. With the flow field computed, the water temperature and salt and suspended sediment concentrations are then computed from their respective transport equations in a semi-implicit fashion. Details can be found in Edinger and Buchak (1979).

11. A note concerning the treatment of the vertical advection term, $\left(w_b b C_s\right)_{k+1/2} - \left(w_b b C_s\right)_{k-1/2}$, in the transport equation for the suspended sediment concentration is required. In the equations for temperature and salinity, the vertical advection term is handled explicitly. However, if the settling velocity is relatively large and/or the vertical layer spacing is

small, an explicit representation in the sediment transport equation will result in a severe restriction on the computational time-step. Therefore, an approximate factorization scheme has been used to implicitly handle the vertical advection term in Equation 8. This is accomplished in the following manner. Before averaging, Equation 8 had the form

$$\frac{\partial C_s}{\partial t} + \frac{\partial UC_s}{\partial x} + \frac{\partial w_b C_s}{\partial z} = \text{R.H.S.} \tag{13}$$

Using

$$\frac{\partial C_s}{\partial t} = \frac{C_s^{n+1} - C_s^n}{\Delta t} + 0(\Delta t) \tag{14}$$

where n is the time level and $0(\Delta t)$ refers to additional terms with factors of Δt. Substituting into Equation 13 yields

$$C_s^{n+1} + \Delta t\left(\frac{\partial UC_s}{\partial x} + \frac{\partial w_b C_s}{\partial z}\right) = C_s^n + \Delta t\ (\text{R.H.S.}) + 0(\Delta t^2) \tag{15}$$

However, the left-hand side, written in operator form, can be factored as

$$(1 + \Delta t\ D_x')(1 + \Delta t\ D_z')\ C_s^{n+1} = C_s^{n+1} + \Delta t\ D_x' C_s^{n+1} + \Delta t\ D_z' C_s^{n+1} + 0(\Delta t^2) \tag{16}$$

where

$$D_x' C_s^{n+1} = \left(\frac{\partial UC_s}{\partial x}\right)^{n+1} \quad ; \quad D_z' C_s^{n+1} = \left(\frac{\partial w_b C_s}{\partial z}\right)^{n+1}$$

The following sequence of equations can then be written for Equation 16:

$$(1 + \Delta t\ D_x')\bar{C}_s = C_s^n + \Delta t\ (\text{R.H.S.}) \tag{17}$$

$$(1 + \Delta t\ D_z')C_s^{n+1} = \bar{C}_s + O(\Delta t^2) \tag{18}$$

Thus, with Equation 17, computations are first made along the channel without considering the vertical advection term. This solution is then used in a vertical sweep with Equation 18 to yield the final suspended sediment concentration field at the new time level. Unlike standard alternating direction implicit schemes, to an accuracy of $O(\Delta t^2)$, no iteration is required. With this solution procedure the settling velocity of the suspended sediment does not influence the allowable computational time-step.

12. The major advantage of the basic solution scheme employed in LAEMSED is that the extremely restrictive stability criterion based upon the speed of the free surface gravity wave, i.e., $\Delta t < (\Delta x / \sqrt{gH_{max}})$, where H_{max} is the maximum water depth, is removed. However, since the convective terms and baroclinic term in the longitudinal momentum equation, as well as the vertical diffusion and advection terms in the temperature and salt transport equations, are lagged in an explicit fashion, the following stability criteria still remain:

$$\Delta t < \frac{\Delta x}{U} \tag{19}$$

$$\Delta t < \frac{\Delta x}{\sqrt{\frac{\Delta\rho}{\rho} g h_w}} \tag{20}$$

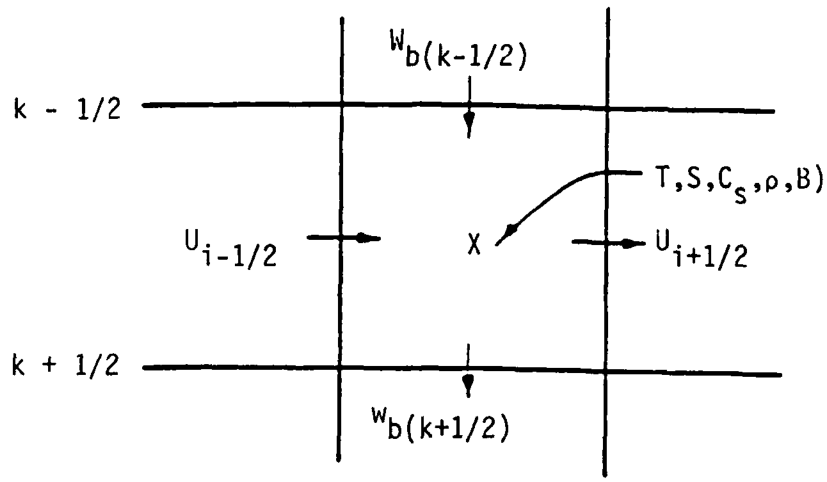
$$\Delta t < \frac{h^2}{2D_z} \tag{21}$$

$$\Delta t < \frac{h}{w_b} \tag{22}$$

where $\Delta\rho$ is the density difference between the fresh and saline waters and h_w is the height of the density flow.

13. The finite difference grid employed in LAEMSED is illustrated in the following sketch. As shown, the velocity components are defined on the faces of a cell, with the water temperature, salinity, suspended sediment

COMPUTATIONAL GRID



concentration, estuary width, and corresponding density defined at the center. Values of variables needed at locations where they are not defined are obtained by averaging, e.g. $w_{b(\text{cell center})} = (1/2)\ w_{b(k-1/2)} + w_{b(k+1/2)}$.

14. An upwind difference scheme is employed in the representation of the advective terms in LAEM. However, it was found that such a first-order scheme, which is quite diffusive, did not result in the computation of a sharp salinity front on Little Back River. Therefore, a combined upwind and centered difference scheme taken from Sheng (1983) was implemented for the advective term in the salt transport equation.

Governing Bed Equations

15. The routines in LAEMSED that compute the exchange of sediment between the sediment bed and the water column are modifications of those found in a vertically averaged sediment transport model called STUDH (Thomas and McAnally 1985). The sediment may be treated as either cohesive (clay) or noncohesive (sand). A single, effective grain size is considered for each.

Conceptual basis

16. The following are basic assumptions:

a. Basic processes in sedimentation can be grouped into erosion, entrainment, transportation, and deposition.

b. Flowing water has the potential to erode, entrain, and transport sediment whether or not sediment particles are present.

c. Sediment on the streambed will remain immobile only as long as the energy forces in the flow field remain less than the critical shear stress threshold for erosion.

d. Even when sand particles become mobile, there may be no net change in the surface elevation of the bed. A net change in the surface would result only if the rate of erosion was different from the rate of deposition--two processes that occur continually and independently.

e. Cohesive sediments in transport will remain in suspension as long as the bed shear stress exceeds the critical value for deposition. In general, simultaneous deposition and erosion of cohesive sediments do not occur.

f. The structure of cohesive sediment beds changes with time, overburden, and ambient water conditions.

g. The major portion of sediment in transport can be characterized as being transported in suspension, even that part of the total load that is transported close to the bed.

Bed shear stress

17. Several options are available for computing the shear velocity u_* used in the equation for bed shear stress τ_b

$$\tau_b = \rho u_*^2 \tag{23}$$

a. Smooth-wall log velocity profile

$$\frac{u}{u_*} = 5.75 \log 3.32 \frac{u_* h}{\nu} \tag{24}$$

where

u = flow velocity in bottom computational cell, ft/sec

h = bottom layer thickness, ft

ν = kinematic viscosity of water, ft^2/sec

b. The Manning shear stress equation

$$u_* = \frac{\sqrt{gu}\,n}{\sqrt{CME}\,h^{1/6}} \tag{25}$$

where

n = Manning's roughness coefficient

CME = coefficients of 1 for metric units and 1.486 for English units

c. A Jonsson-type equation for surface shear stress (plane beds) caused by waves and currents

$$u_* = \left[\frac{1}{2} \left(\frac{f_w u_{om} + f_c u}{u_{om} + u} \right) \left(u + \frac{u_{om}}{2} \right) \right]^{1/2} \qquad (26)$$

where

f_w = shear stress coefficient for waves

u_{om} = maximum orbital velocity of waves

f_c = shear stress coefficient for currents

Bed source term

18. The transport equation for suspended sediment, Equation 8, contains a bed source term H_s . The form of this term is

$$H_s = \alpha_1 C_{s_b} + \alpha_2 \qquad (27)$$

where C_{s_b} is the sediment concentration near the bottom, and is the same for deposition and erosion of both sands and clays. Naturally, if deposition is occurring, H_s will be negative, whereas a positive value will result if erosion is taking place. In Equation 27, α_1 is a coefficient that has the dimensions of 1/sec while α_2 is the equilibrium concentration portion of the source term, in $kg/m^3/sec$. Methods of computing α_1 and α_2 depend on the sediment type and whether erosion or deposition is occurring.

19. Sand transport. The supply of sediment from the bed (i.e., the sediment reservoir) is controlled by the transport potential of the flow and availability of material in the bed. The bed source term is

$$H_s = \frac{C_{eq} - C_{s_b}}{t_c} \qquad (28)$$

where

C_{eq} = equilibrium concentration, kg/m^3

t_c = characteristic time for effecting the transition, sec

There are many transport relationships for calculating C_{eq} for sand. The

Ackers-White (1973) formula was adopted for STUDH and thus is also used in LAEMSED.

20. The characteristic time t_c is somewhat subjective. It should be the amount of time required for the concentration in the bottom layer to change from C_{s_b} to C_{eq}. In the case of deposition, t_c is related to fall velocity. The following expression is employed:

$$t_c = \text{larger of} \begin{cases} C_d \dfrac{h}{W_s} \\ \text{or} \\ \Delta t \end{cases} \tag{29}$$

where

C_d = coefficient for deposition

W_s = fall velocity of sediment particle, m/sec

In the case of erosion, there are no simple parameters to employ. The following expression is used:

$$t_c = \text{larger of} \begin{cases} C_e \dfrac{h}{u} \\ \text{or} \\ \Delta t \end{cases} \tag{30}$$

where C_e is the coefficient for entrainment.

21. Clay transport. Deposition rates of clay beds are calculated with the equations of Krone (1962).

$$H_s = \begin{cases} -\dfrac{2W_s}{h} C_{s_b} \left(1 - \dfrac{\tau_b}{\tau_d}\right) \text{ for } C_{s_b} < C_c & (31) \\ -\dfrac{2V_k}{h} C_{s_b}^{5/3} \left(1 - \dfrac{\tau_b}{\tau_d}\right) \text{ for } C_{s_b} > C_c & (32) \end{cases}$$

where

τ_b = bed shear stress

τ_d = critical shear stress for deposition

C_c = critical concentration = 300 mg/ℓ

$V_k = W_s/C_c^{4/3}$

Erosion rates are computed by a simplification of Parthenaides' (1962) results for particle by particle erosion. The source term is computed by

$$H_s = \frac{E}{h}\left(\frac{\tau_b}{\tau_e} - 1\right) \tag{33}$$

where

E = erosion rate constant

τ_e = critical shear stress for particle erosion

22. When bed shear stress is high enough to cause mass failure of a bed layer, the erosion source term is

$$H_s = \frac{T_L \rho_L}{h \Delta t_f} \quad \text{for} \quad \tau_b > \tau_s \tag{34}$$

where

T_L = thickness of the failed layer

ρ_L = density of the failed layer

Δt_f = time interval over which failure occurs

τ_s = bulk shear strength of the layer

Bed model

23. The sink-source term H_s in Equation 8 becomes a source-sink term for the bed model, which keeps track of the elevation, composition, and character of the bed. A basic assumption is that the width over which deposition or erosion occurs is the input width of the bottom computational cell.

24. Sand beds. Sand beds are considered to consist of a sediment reservoir of finite thickness, below which is a nonerodible surface. Sediment is added to or removed from the bed at a rate determined by a weighted value of the sink/source term at the previous and present time-steps. The mass rate of exchange with the bed is converted to a volumetric rate of change by the bed porosity parameter.

25. Clay beds. Clay beds are treated as a succession of layers. Each layer has its own characteristics as follows:

a. Thickness.

b. Density.

c. Age.

d. Bulk shear strength.

e. Type.

In addition, the layer type specifies a second list of characteristics:

a. Critical shear stress for erosion.

b. Erosion rate constant.

c. Initial and 1-year densities.

d. Initial and 1-year bulk shear strengths.

e. Consolidation coefficient.

New clay deposits form layers up to a specified initial thickness and then increase in density and strength with increasing overburden pressure and age. Variation with overburden occurs by increasing the layer type value by one for each additional layer deposited above it. Change with time is governed by the equations

$$f(t) = \begin{cases} f(t_0) + \left[f(t_1) - f(t_0)\right] \log (9t + 1) & 0 \le t \le 1 \text{ year} \quad (35) \\ f(t_1) + M \log t & 1 \text{ year} \le t \quad (36) \end{cases}$$

where

f = time-varying characteristics of density or bulk strength

t_0 = time = zero

t_1 = time = 1 year

M = consolidation coefficient

Mass deposition rates are converted to volumetric deposits by the specified density for the type 1 layer, and erosion rates are converted to a corresponding volume by the actual density of the eroding layer.

Data Requirements

26. The major data input required by LAEMSED is the geometry data describing the system. At the center of each computational cell the width of the estuary or river must be prescribed. For the study described herein,

these widths were obtained from hydrographic survey data furnished by the US Fish and Wildlife Service, NOAA charts, and dredging surveys. In addition, overbank areas that contribute to the storage of water during flood tide must be included in the model geometry. Other data required are the boundary conditions that drive the internal flow field. At a river (upstream) boundary, a discharge hydrograph must be prescribed along with the temperature, salinity, and concentration of suspended sediment associated with the inflow. At the ocean boundary the tide must be prescribed. At tidal boundaries, vertical distributions of temperature, salinity, and suspended sediment concentrations must also be prescribed. In the present study, the water temperature was assumed constant and the surface heat exchange was set to zero. However, for problems in which thermal effects are considered, short-wave solar radiation, air temperature, dew point temperature, and wind speed must be known to compute the coefficients required in the computation of the rate of surface heat exchange.

27. In addition to the water column data described in the previous paragraph, information about the sediment and the initial bed structure must be input. A constant settling velocity is currently assumed. Default values for the characteristic parameters of the different type layers that can make up a sediment bed are provided in LAEMSED, e.g., the density of a freshly deposited type 1 layer is defaulted to 90 kg/m^3. However, any of these values can be changed through input data, if desired.

PART III: 1985 HYDRODYNAMIC SURVEY

28. To provide field data for model verification, WES conducted a field study in the Savannah Estuary in April 1985. Tides, velocities, salinity, and suspended sediment concentrations were recorded at several locations along the estuary from its mouth to the head of tide. These data are presented in Appendixes A-F. Data collection equipment and procedures were the same as those described by Coleman et al. (1988).

Station Location

13-hr survey

29. During the data collection period, an intensive 13-hr survey was conducted along the Savannah River from Fort Pulaski (river mile 0.0) upstream to Ebeneezer Landing. The survey consisted of 12 ranges, each with 2 or 3 stations located across the channel (Figure 1). Range 1 was located at Fort Pulaski. Ranges 2 and 3 and Ranges 5-7 were established along Front River. Range 4 was located in the sediment trap. Ranges 8, 8A, and 9 were located at Fields Cut, Elba Island Cut, and the Intracoastal Waterway Alternate Route, respectively. Ranges 10 and 11 were established along Little Back River, and Range 12 was established at Ebeneezer Landing. The number of stations, depths, and day of data collection at each range are listed in Table 1.

30-day survey

30. During the 30-day survey, 10 tide gages were installed along the estuary to provide tide elevation measurements (Figure 1). One tide gage was installed at Fort Pulaski. One tide gage was installed at Fields Cut but failed to operate properly during the survey period. Three tide gages were installed along Front River. Two tide gages were installed along the Savannah River at river miles 27.5 and 30.8, respectively. Another tide gage was located just upstream of the tide gate. One tide gage was installed along Middle River, and a final tide gage, which failed to operate properly, was installed along Little Back River. These locations are summarized in Table 2.

Methods

13-hr survey

31. Two 13-hr surveys were conducted on 3-4 April 1985 from 0600 to 1900 each day. Data were collected at Ranges 8-12 on 3 April and at Ranges 1-7 on 4 April. During the survey, current velocity measurements were taken at 1-hr intervals along the left and right channel prism line and along the center line of Ranges 1-6. Range 7 consisted of two transects, one along Front River near river mile 19.7 and another at the junction of Middle River and Front River above the Argyle Island Turning Basin. For Ranges 8-12, measurements were taken at a single midchannel station. Current velocity measurements were taken at five depths for each station at Range 1: near surface, two-thirds above the bottom, middepth, one-third above the bottom, and 2 ft above the bottom, hereafter referred to as simply bottom. For Ranges 2-7 and Range 12, velocity data were collected at four depths: surface, middepth, 4 ft above the bottom, hereafter referred to as near bottom, and bottom. For remaining Ranges 8-11, velocity data were collected at three depths: surface, middepth, and bottom. Current velocity measurements were obtained with the use of a magnetic compass indicator and a Price-type current meter. A sample tube was attached to the meter and weight assembly, and water samples were collected to be analyzed later for salinity and suspended sediment concentration.

32. In addition to the salinity and suspended sediment samples taken at each of the 12 ranges, Niskin tube samples were collected approximately twice during the survey at each range. Analyses of these samples provided an estimate of in situ settling velocities of suspended material.

33. Throughout the entire Savannah River system, bottom grab samples were collected using a mechanical claw. The samples were later analyzed for grain size distribution, specific gravity, and organic content.

34. Marker buoys were anchored at each of the sampling stations for each range to identify the station location. The current meter, compass indicator, sampling tube, and pump were installed on workboats provided by the Savannah District.

30-day survey

35. The 30-day survey was conducted from 20 March through 18 April 1985. Tide elevations were recorded using float-driven Fisher-Porter type

1550 surface elevation level recorders which were installed over 10-cm-diam plastic pipe stilling wells. The apparatus contained a punch tape continuous recorder that recorded the water-surface elevation every 15 min over the 30-day period.

PART IV: FLOW-SALINITY VERIFICATION

Numerical Grid

36. As previously noted, the Savannah Estuary consists of a series of interconnecting channels. To properly model the impact of channel deepening on salinity intrusion and shoaling in Front River, all channels and channel connections had to be included. The final grid consisted of 16 branches. Seven of these were inserted to aid in a more realistic representation of the movement of water into and out of marsh storage. Although the locations of these seven channels correspond approximately to the location of actual drainage paths in the estuary, their length and channel dimension were arbitrarily chosen to provide better model results. Ocean boundaries were extended 10 miles offshore to minimize the impact of channel deepening on the salinity boundary condition. The locations of all branches are listed in Table 3 and are shown on Figure 2.

37. Each branch was subdivided into arbitrarily chosen grid spacings with a minimum of 200 m to a maximum of 4,000 m. For each river branch, cross sections were constructed at the center of each spaced interval from NOAA charts, dredging surveys, and survey data provided by the Savannah District and the US Fish and Wildlife Service. As previously noted, cross sections for the marsh channels were arbitrarily selected to aid in model adjustment. The grid spacings and the number of cross sections (ΔX's) for each branch are listed in Table 4. Each cross section was divided vertically into 0.9144-m cells with an average channel width input at the center of each cell.

38. To properly model channel hydrodynamics, the extensive marsh areas that are inundated during the flood portion of the tide must be addressed. These areas are represented through the specification of overbank planform areas associated with each ΔX. The final values selected were determined by trial-and-error adjustment of the model and match approximately the total flooded area as indicated by the NOAA charts.

39. The final numerical grid for LAEMSED consisted of 16 branches containing a total of 199 reaches (ΔX's). The maximum number of vertical cells was 20. Of course, many of the cells in the 199 × 20 grid were either dummy cells required at the ends of each branch or were inactive ones. A

computational time-step of 60 sec was used in all model runs.

Tide Gate Operation

40. The tide gate located on Back River is a gravity-operated structure. Therefore, when the water level on the river side exceeded that on the ocean side, LAEMSED initiated the closing of the gate. This was accomplished by first decreasing the Chezy coefficient in the reach containing the gate by a factor of one-fifth each time-step for five time-steps. At the end of the fifth time-step after the closing was initiated, flow was completely shut off through the gate by setting the velocity to zero. This procedure reduced the initial shock to the system caused by the gate closing. When the ocean-side water level exceeded the river-side level, the gate was fully opened in one time-step and flow through the reach was computed in a normal fashion.

Sensitivity of Chezy and Diffusion Coefficients

41. Both the x-momentum and the constituent transport equations contain eddy coefficients in both the x- and z-directions. Two orders of magnitude change in the x-direction coefficients in the Lower Mississippi applications by Johnson, Boyd, and Keulegan (1987) resulted in little change in the computed flow and salinity fields. However, the model is more sensitive to variations in the vertical coefficients (D_{z_o} in the constituent equations and A_{z_o} in the momentum equation). This is illustrated in Figures 3 and 4 taken from Johnson, Boyd, and Keulegan (1987). These results show that the more dominant of the two coefficients influencing salinity intrusion is the vertical diffusion coefficient D_{z_o} in the salinity transport equation. Relatively large variations in A_{z_o} seem to have little influence on the computed flow field and thus little influence on the salinity field. Edinger and Buchak (1981) arrived at a similar conclusion in sensitivity studies from an application on the Potomac River.

42. The major coefficient to be varied to match a computed flow field with observed data is the Chezy coefficient C. Figure 5, taken from Johnson, Boyd, and Keulegan (1987), illustrates that the value of C has a major influence on the water-surface profile computed. Since the flow and salinity fields are coupled through the longitudinal pressure gradient, major

changes in the water surface result in significant changes in the salinity field.

1985 Application

43. Verification of the flow and salinity computations in LAEMSED was accomplished through the use of the field data collected in April 1985 and discussed in Part III and data collected in 1980.

Available 1985 data

44. Recorded tides at seven locations and velocity and salinity measurements near the surface, at middepth, and near the bottom at eight locations were used for adjustment purposes. The velocity and salinity data used were those collected in the middle of the channel. These data were collected over two 13-hr periods starting at 0600 on 3 April and ending at 1900 on 4 April. Daily averaged freshwater inflows at Ebeneezer Landing and the tide at Fort Pulaski were recorded for several days before and after the 13-hr detailed surveys. Figures 6-9 illustrate that typical middle-of-the-channel salinity data are a good representation of the laterally averaged data. These results serve to substantiate the applicability of a laterally averaged model.

Boundary conditions

45. As previously noted, the ocean boundary of the numerical model of the Savannah Estuary was extended 10 miles seaward to remove the influence of channel modifications on the applied vertical distribution of salinity. With the extended boundary, the ocean salinity was set to be a constant 32 ppt over the water column. In addition, in the ocean portion of the model, the vertical diffusion coefficient D_z was forced to be 90 percent of its allowable maximum from stability considerations, whereas in the remainder of the system D_z was computed from Equation 11 with $D_{z_o} = 10^{-6}\ m^2/sec$. Figure 10 demonstrates the impact of forcing maximum vertical diffusion in the ocean on salinities at Fort Jackson.

46. The tide imposed at the ocean boundary was that recorded at Fort Pulaski but lagged by 30 min to account for the 10-mile displacement of the boundary. A comparison of the computed and recorded tide at Fort Pulaski is given in Figure 11.

47. At the upstream end of the model, near Ebeneezer Landing, the freshwater discharge was prescribed. These data were given as daily averages

with a linear interpolation employed to provide values at each time-step. The freshwater flows during the adjustment period are given in the following tabulation.

Flow, cfs	Date, 1985
7,360	3/29
7,470	3/30
7,470	3/31
7,580	4/01
7,360	4/02
7,140	4/03
7,140	4/04
7,140	4/05
7,140	4/06

Results

48. The model runs were initiated from a hot start consisting of the computed conditions after a 10-day run in which the ocean water-surface elevation was held constant at mean low water and the freshwater inflow was fixed to be 8,400 cfs. Using results from this application as initial conditions, approximately 6 days were run as a start-up period before computed results were compared to the field data from the 13-hr surveys. The Chezy coefficient for each cross section and the marsh planform areas selected to achieve the results presented are given in Tables 5 and 6, respectively.

49. Comparisons of the computed and recorded tides at seven locations are presented in Figures 11-17. Both phase and range are matched reasonably well, with the worst comparison being at Gage 6 on Front River above McComb's Cut (Figure 14). Obviously, additional adjustment of marsh storage would result in a better matching of the range, but perhaps to the detriment of results at other locations.

50. Comparisons of computed and recorded surface, middepth, and near-bottom velocities are presented in Figures 18-26 at nine locations. Six are on Front River in the navigation channel, two are on Little Back River, and one is in the sediment trap. Computed values near the bottom at Range 3 were not output due to a "step" in the bottom (Figure 20c). As can be seen, good agreement is obtained at most locations along Front River with excellent

agreement at the two locations on Little Back River.

51. A comparison of velocities in the sediment trap is presented in Figure 21. The values are quite low, with good comparison near the surface. However, a strange behavior in the field data at middepth and near the bottom was observed. It appears that a rather strong ebb flow occurred when prototype surface flow and computed flow at all depths was in the flood direction.

52. Comparisons of computed and recorded salinities are presented in Figures 27-35 at the same locations as for the velocity comparisons. Good agreement with the field data is realized at most locations along Front River.

53. As shown in Figure 30, the salinity data collected at the sediment trap (range 4) reveals extreme scatter. No conclusions can be drawn from these comparisons.

54. The salinity comparisons at Ranges 10 and 11 on Little Back River are presented in Figures 34 and 35. Good agreement is realized at Range 10. Although the agreement at Range 11 is not as good, the maximum values are reproduced well and the flushing along Little Back River appears to be properly computed. The spread of the computed salinity profile at Range 11 can be partially attributed to the numerical dispersion of the salinity front, although the combined centered and upwind scheme employed for the advective term in the salt transport equation does reduce the dispersion.

1980 Application

55. The model was next run using field data collected in 1980 by WES.* No additional adjustments were made to the model prior to these runs. These data did not cover the estuary as extensively as the 1985 data set. Tidal data and velocity and salinity data were available at three locations for comparison. The 1980 run was set up in the same manner as the 1985 run, i.e., water-surface elevations were imposed at the ocean ends along with a constant salinity of 32 ppt, while the freshwater inflows in the following tabulation were prescribed above Ebeneezer Landing. The same values for storage areas and Chezy coefficients selected in the final 1985 run were employed. It should be noted that geometry data along Front River were slightly different.

* J. H. G. Shingler, G. M. Fisackerly, D. A. Crouse, and J. W. Parman. 1981. "Savannah River Estuary Study," unpublished report, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Flow, cfs	Date, 1980
7,310	4/14
7,870	4/15
9,060	4/16
9,380	4/17
8,680	4/18
8,900	4/19
9,180	4/20
8,520	4/21

In the 1985 runs, recent widenings were incorporated, whereas these were removed for the 1980 verification run.

56. Comparisons of computed and recorded tides at Fort Pulaski, river mile 5.9, and Fort Jackson are presented in Figures 36-38. Comparisons of velocities are shown in Figures 39-41, and comparisons of salinities are given in Figures 42-44. Results on tides and velocities are about equivalent to those obtained in the final 1985 run. However, the salinity field data shown in Figures 42-44 are of little or no value. Shingler et al.* reported that an industrial discharge into Front River just before the time of the field survey contaminated the salinity data; thus, these data were useless for model verification purposes.

57. Additional confidence in the model's ability to accurately compute salinity conditions in Little Back River was obtained through an inspection of salinity records provided by the Savannah District from a station located near Range 11. These data were for the period of 24 February-2 May 1985. Values of salinity ranged from near zero to values in excess of 7 ppt. Actual freshwater inflows during the period of the data recorded ranged from about 11,000 to 7,000 cfs. Model results from production runs to be discussed later reveal that with a freshwater inflow of 8,400 cfs, computed salinities at Range 11 vary from near zero at low-water slack during tide ranges near 5 ft to values near 8 ppt at high-water slack during tides with a range near 10 ft. These results indicate that the model is approximately reproducing the proper range of salinity conditions on Little Back River.

58. No salinity data as far upstream as McComb's Cut were collected

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* Op. cit.

during the 1985 survey. However, data collected during November 1986 by the Savannah District imply that salt rarely moves beyond the I-95 bridge at mile 27.5. As illustrated in Figure 45, the numerical model computes a greater intrusion of salinity above McComb's Cut than observed, although the salinity level at McComb's Cut is in agreement with the observed value.

PART V: SEDIMENT VERIFICATION

59. LAEMSED was adjusted to reproduce shoaling rates obtained from dredging records in the navigation channel by running the model for the complete 28-day cycle of tides recorded at Fort Pulaski during the 1985 survey. Figure 46 illustrates the tide range at Fort Pulaski relative to an arbitrary datum. The mean low-water elevation was determined to be 20.18 ft from the observed record and was then used to adjust the elevations shown to specify values relative to the zero water-surface elevation in the model. Three separate freshwater inflows were assumed: a low inflow of 5,200 cfs, an average inflow of 8,400 cfs, and a high inflow of 16,000 cfs. Computed shoaling rates along Front River and in the sediment trap obtained by averaging results over the 28-day cycle of tides were compared with estimates based upon dredging records from 1977-1980.

Initial and Boundary Conditions

60. Initial conditions on flow and salinity were the same as previously discussed in paragraphs 45-47. A constant concentration of suspended sediment of 300 ppm in the water column and the assumption of no sediment on the bed completed the initial state. Once again, LAEMSED was run with a start-up period, with results then computed over the 28-day period for comparison. Based on 1985 survey measurements, constant suspended sediment concentrations of 20 and 300 ppm were specified as boundary conditions at Ebeneezer Landing and the ocean boundaries, respectively. These conditions were not varied with either freshwater inflow or tidal conditions since the field data did not show such a variation. Figure 47 illustrates the relative independence of the sediment concentration with inflow, in the flow range tested, at a station above Ebeneezer Landing.

Bed Model

61. Shoaling problems in the Savannah Estuary result primarily from the deposition of fine-grained material. Thus the sediment was considered to be clay and the bed model discussed in Part II was used. Only two layers were allowed in the bed model, with no sediment on the bed initially. The bed

shear stress was computed from Equation 23 with the shear velocity determined from the smooth-wall log velocity profile given in Equation 24. The thickness of the upper layer was set to be constant at 0.01 m, representing recently deposited material, whereas the thickness of the bottom layer was variable. The concentration of material in both layers was taken to be 400 kg/m^3, yielding a bulk density of the bed of 1.25 gm/cc. Bottom grab samples from the 1985 field survey were not tested for bulk density but did reveal that most of the material in the lower estuary is fine-grained.

Model Setup

62. The basic model, verified for flow and salinity, was applied with the option for sediment computations turned on. The geometry data used in Front River were the same as in the 1980 verification run; i.e., recent widenings were not included since computed shoaling rates were to be compared with dredging records from 1977-1980.

63. As noted, during the 1985 survey, suspended sediment concentrations at Ebeneezer Landing averaged about 30 ppm and at Fort Pulaski about 300 ppm. In initial model testing, it was found that with the suspended sediment concentrations at the boundaries unchanged, the inflow at Ebeneezer Landing had little impact on computed shoaling rates in the navigation channel, although such shoaling is probably a result of the movement of material from upstream, with the freshets (high discharges) being the primary sediment sources to the lower estuary. As discussed by Krone (1972), the sediment is not immediately deposited in the Front River channel but instead is carried into the lower estuary. As the lower estuary sediment is reworked over time by tidal currents, it is gradually carried into Front River from the lower estuary and eventually deposits along the Front River channel. The end result is that the important factor in modeling shoaling along Front River is the tidal current as long as a sufficient sediment supply is provided at the downstream boundary. Therefore, to save on computer costs it was decided that the remaining runs in the sediment adjustment phase would be made using an average freshwater inflow of 8,400 cfs.

64. The major parameters to be adjusted to match computed and recorded shoaling rates are settling velocity and critical shear stress for erosion. Other parameters such as the critical shear stress for deposition were set to

be model default values taken from Thomas and McAnally (1985). The settling velocity was determined from Niskin tube measurements during the 1985 survey to be 0.001 m/sec and thus was considered fixed in all runs. Therefore, the only parameter varied was the critical shear stress for erosion. After several runs, values of 0.6 N/m^2 in the top layer and 1.15 N/m^2 in the bottom layer were selected. Such values are reasonable for a bed density of 1.25 gm/cc (McDowell and O'Connor 1977).

Results

65. A comparison of the shoaling rates computed by LAEMSED and those estimated from dredging records along Front River and in the sediment trap is shown in Figure 48. The computed shoaling rate, expressed as infill rate in feet per year, was determined by dividing the net change in bed elevation over the 28-day cycle of tides by 28 to yield an average daily infill rate. This was then multiplied by 365 to yield an average annual rate. Although the absolute values differ somewhat, the areas of primary shoaling are computed correctly and, overall, the agreement is good. Considering that reported dredging volumes are often imprecise and that infill rates are dependent upon the assumed bed density, the sediment model behavior is reasonable.

66. During the 1985 survey, suspended sediment concentrations were obtained along with the velocity and salinity data. Comparisons of recorded and computed suspended sediment concentrations versus water depth at several locations at 1800 on 4 April 1985 during flood phase are given in Figures 49-54. The comparison is considered fair, although computed values in the water column are generally lower. It appears that either the settling velocity is too high in the model or the vertical diffusion computed is too low. This may be because the stratification resulting from the large sediment concentration near the bottom has a retarding effect on diffusion computed upwards into the water column.

PART VI: CHANNEL DEEPENING ANALYSIS

67. As previously noted, one of the factors being considered in the Savannah Harbor Comprehensive Study is an evaluation of the impact on shoaling and salinity intrusion in the estuary, particularly in Little Back River, of deepening a 500-ft-wide navigation channel. This was addressed by first enlarging the navigation channel, as represented by the 1980 geometry data, in some reaches along Front River to ensure a minimum navigation width of 500 ft. Results from this run are referred to as base conditions. Additional runs called Plan 1 and Plan 2 were then made in which the navigation channel and sediment trap depths were increased by 3 and 6 ft, respectively. The actual depth increments proposed in the comprehensive study are 2, 4, and 6 ft. An increment of 3 ft was used here due to the vertical grid spacing in LAEMSED being 3 ft (0.91 m). Results for 2- and 4-ft increases in depth can be obtained by interpolation.

Salinity Intrusion Results

68. Each of the three conditions, i.e., base, Plan 1 (3-ft deepening), and Plan 2 (6-ft deepening) was run with the 28-day cycle of tides in Figure 46 prescribed at the ocean boundaries for low (5,200 cfs), average (8,400 cfs), and high (16,000 cfs) freshwater inflows at Ebeneezer Landing. Near-surface and near-bottom salinity profiles at approximately low- and high-water slack along Front River and Back River above the tide gate are presented in Figures 55-102 for a neap tide with a range of 5.0 ft and a spring tide with a range of 10.3 ft. These tides occurred on days 9 and 17, respectively, of the tidal record shown in Figure 46.

69. Salinity results along Front River are presented in Figures 55-78. When these results are viewed, the history of the boundary conditions leading up to the time at which results were plotted must be considered. For example, for approximately the same tide and freshwater inflow, Figure 45 shows a salinity of about 3 ppt computed at mile 27 on Front River, whereas a salinity of about 10 ppt is shown in Figure 61. However, the low flow shown in Figure 45 was held constant for only 6-7 days, whereas that for the results presented in Figure 61 was held constant for about 20 days. In addition, although the tide range at Fort Pulaski was about the same when both salinity

profiles were plotted, the results in Figure 45 are for a 9.3-ft tide at the beginning of a spring cycle, whereas those in Figure 61 are for a 10.3-ft tide that occurred well into the spring cycle. General conclusions are that increased channel depths influence bottom salinities more than surface salinities and that the influence becomes more pronounced as the freshwater inflow increases. The maximum salinity changes occurred with a freshwater inflow of 16,000 cfs at low-water slack during a neap tide.

70. Salinity results along Back River are presented in Figures 79-102. The conclusion from these results is that deepening the navigation channel by as much as 6 ft will have a minor impact upon salinities near the Savannah National Wildlife Refuge water intake at about mile 10 on Little Back River above the tide gate. The maximum increase will occur at high-water slack during a spring tide and a low freshwater inflow but will be only about 0.5 ppt.

71. Base test results for high- and low-water slack conditions from Figures 79-102 have been superimposed to yield Figures 103-108, which illustrate the range of salinity conditions to be expected on Back River for certain inflow and tidal conditions with the existing channel conditions. Expected salinity conditions near the refuge intake are summarized in the following tabulation:

	Maximum Salinity at Refuge Intake, ppt	
Inflow, cfs	Neap Tide (5.0 ft)	Spring Tide (10.3 ft)
5,200	5.2	11.6
8,400	2.0	7.4
16,000	0.0	2.0

	Minimum Salinity at Refuge Intake, ppt	
Inflow, cfs	Neap Tide (5.0 ft)	Spring Tide (10.3 ft)
5,200	0.8	2.2
8,400	0.0	1.2
16,000	0.0	0.2

From an inspection of Figure 104, it can be seen that the salinity drops sharply between miles 10 and 12. It should be remembered that meteorologic conditions, e.g., wind, were not considered in the modeling.

72. Particular conclusions drawn from the computations presented in Figures 55-108 are listed as follows:

a. For freshwater flows up to 16,000 cfs, an increase in channel depth of 6 ft resulted in maximum increases of salinity near the bottom of the navigation channel of about 3 ppt and maximum increases near the surface of less than 1 ppt.

b. Salinity increases in the navigation channel as a result of channel deepening up to 6 ft appear to be relatively independent of tide range.

c. Changes in salinity in the navigation channel as a result of channel deepening up to 6 ft increase with increasing freshwater inflow.

d. For the range of conditions tested, an increase in the depth of the navigation channel of up to 6 ft will result in maximum salinity increases near the wildlife refuge of less than 0.5 ppt. These slight increases will occur at lower freshwater flows, e.g., less than 9,000-10,000 cfs, during spring tides.

e. For a freshwater flow of 5,200 cfs and a tide range of 5.0 ft, salinities near the wildlife refuge varied from about 1 to 5 ppt, whereas with a tide range of 10.3 ft, salinities varied from about 2 to 12 ppt. However, it should be remembered that the salinity front is computed to be only slightly upstream of the intake.

f. For a freshwater flow of 8,400 cfs and a tide range of 5.0 ft, salinities near the wildlife refuge varied from zero to perhaps 2 ppt, whereas with a tide range of 10.3 ft, salinities varied from about 1 to 7 ppt.

g. For a freshwater flow of 16,000 cfs and a tide range of 5.0 ft, no saline water intruded as far upstream on Little Back River as the refuge intake, whereas with a tide range of 10.3 ft, salinities near the intake varied from near zero to about 2 ppt.

Shoaling Results

73. The changes in shoaling rates along the navigation channel and in the sediment trap as a result of increased channel depths are presented in Figure 109 and in Table 7. Figure 109 illustrates that as the channel depth increased, shoaling in lower Front River (35,000-65,000 ft above the ocean) decreased with a subsequent increase in shoaling in the river reach containing the Kings Island Turning Basin. It should be remembered that channel widths are not constant along the channel. Shoaling near the entrance and in the middle of the sediment trap increased slightly with a slight decrease in the remainder of the trap.

74. As the channel was deepened by 6 ft, the increase in sediment volume in Front River deposited over the 28-day cycle of tides increased to

14.4 percent above the existing condition (Table 7). Deposition in the sediment trap was essentially unchanged for a channel depth increase from 3 to 6 ft.

Influence of the Tide Gate

75. One final model run was made using the 1985 data in which the tide gate was left open at all times. As illustrated in Figure 110, the normal operation of the tide gate resulted in increased salinity levels near the Savannah National Wildlife Refuge water intake at Range 11.

PART VII: SUMMARY AND CONCLUSIONS

Summary

76. Since there is a concern that deepening the navigation channel in the Savannah Estuary may significantly influence the rate of shoaling along Front River as well as salinity intrusion into Little Back River near the Savannah National Wildlife Refuge, a numerical model study was authorized by the Savannah District as part of the Savannah Harbor Comprehensive Study. To accomplish this study, a numerical model called LAEM, which is a laterally averaged estuary model that couples the computation of the flow and salinity fields through the influence of the salinity on the water density, has been modified and applied. Modifications primarily involved incorporating the capability of computing the movement of suspended sediment and the exchange of sediment between the water column and the estuary bed. The resulting model is called LAEMSED.

77. The initial step in the modeling study was a detailed field survey in April 1985 to provide data on tides, velocity, salinity, and sediment for verification of LAEMSED. A limited data set collected in 1980 also was employed in a verification run for flow and salinity. A comparison of the range of recorded salinity over a 4-month period in 1985 on Little Back River with the computed range for similar flow conditions served as additional verification of the model. The resulting model was then applied with a complete 28-day cycle of tides prescribed at the ocean boundaries with adjustments made to the bed model to match computed shoaling rates along the navigation channel and in the sediment trap with rates estimated from dredging records. The model was then applied to address the impact of deepening the navigation channel by 3 and 6 ft. Low, average, and high freshwater inflows were run for the base condition and two plans.

Conclusions

78. In general it is concluded that the numerical model, LAEMSED, provides a very useful tool for assessing the impact of major changes in channel geometry on shoaling rates and salinity intrusion in laterally averaged estuarine systems. Verification of LAEMSED on the Savannah Estuary produced a

model whose computed results were in good agreement with 1985 field data at most locations, although the numerical model does compute an intrusion of salinity above McComb's Cut that is not substantiated by field data collected in 1986.

79. The following are examples of possible future uses of LAEMSED on the Savannah Estuary:

a. Determine the impact on Little Back River salinities and navigation channel shoaling of altering the operation of the tide gate, e.g., every other tidal cycle leave the gate open.

b. Determine the impact of extending the navigation channel on salinity and shoaling conditions.

c. Determine the impact of enlarging McComb's Cut on Little Back River salinities.

However, before LAEMSED can be applied to address the last two items, detailed field data in the upper reaches of the estuary are required. These data should include salinity at several locations for several days during a low freshwater inflow period. In addition, detailed geometry data are required in the upper reaches of the estuary. Consideration should also be given to modifying LAEMSED to better represent the bottom topography as well as allowing for the influence of the channel alignment in McComb's Cut on the distribution of freshwater flow.

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Table 1

Survey Range Locations, 1985

Range	No. of Stations	No. of Depths	Location
		4 April 1985	
R-1	3	5	Fort Pulaski
R-2	3	4	River mile 10.4
R-3	3	4	Fort Jackson
R-4	3	4	Sediment trap
R-5	3	4	Front River
R-6	3	4	Front River
R-7	5	4	River mile 20.5
		3 April 1985	
R-8	1	3	Fields Cut
R-8A	1	3	Elba Island Cut
R-9	1	3	Intracoastal Waterway
R-10	1	3	Little Back River
R-11	1	3	Little Back River
R-12	1	4	Ebeneezer Landing

Table 2

Tide Gage Locations

Tide Gage	Location
1	Fort Pulaski
2*	Fields Cut
3	Fort Jackson
4	Colonial Dock
5	River mile 20.5
6	River mile 27.5
7	River mile 30.8
8	Tide gate (Back River)
9	Middle River, Hwy 17 Bridge
10*	Little Back River

* Inoperable.

Table 3

Branching System

Branch	Location
1	Ebeneezer Landing through McComb's Cut along Back River to Front River
2	From McComb's Cut down Front River to Fort Pulaski
3	Connection from Front River to Hog Island on Back River
4	Middle River
5	Steamboat Island
6	South Channel from Front River to ocean
7	Elba Island Cut
8	Marsh channel on Back River
9	Marsh channel on Back River
10	Marsh channel on Front River
11	Marsh channel on Little Back River
12	Marsh channel on Little Back River
13	Marsh channel on Front River
14	Rifle Cut
15	Marsh channel on Middle River
16	Union Creek

Table 4

Schematization

Branch	ΔX , m	No. of ΔX's
1	1,074	55
2	1,610	36
3	1,000	4
4	1,006	8
5	386	6
6	1,610	19
7	468	3
8	4,000	4
9	4,000	4
10	2,500	4
11	4,000	4
12	4,000	4
13	4,000	4
14	200	4
15	4,000	4
16	1,000	4

Table 5

Chezy Coefficents, $m^{1/2}$/sec (I^{th} Index Increases Across and Runs Through Branches 1, 2, ... 16)

35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
45.0	45.0	45.0	45.0	45.0	45.0	40.0	40.0	40.0	40.0
40.0	30.0	30.0	70.0	70.0	70.0	70.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	50.0	50.0
55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0
60.0	60.0	60.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
70.0	70.0	70.0	70.0	70.0	60.0	60.0	60.0	60.0	60.0
30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
60.0	60.0	30.0	30.0	30.0	30.0	30.0	30.0	60.0	60.0
70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	60.0
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45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0

Table 6

Marsh Planform Areas, 1,000 m^2 (I^{th} Index Increases Across and Runs Through Branches 1, 2, ... 16)

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	5,000	5,000
5,000	5,000	5,000	5,000	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	5,000	5,000	5,000	5,000	5,000
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	27,000
0	0	0	0	0	27,000	0	0	0	0
0	0	0	0	0	0	0	6,000	0	0
0	0	0	3,000	0	0	0	0	0	12,000
0	0	0	0	0	0	0	0	0	0
0	18,000	0	0	0	0	0	0	0	0

Table 7

Effect of Channel Deepening on Sediment Deposition

Condition	Front River: Yearly Volume cu yd	Front River: % Change	Sediment Trap: Yearly Volume cu yd	Sediment Trap: % Change
Base	4,170,000	--	2,340,000	--
Plan 1	4,540,000	8.9	2,460,000	5.1
Plan 2	4,770,000	14.4	2,460,000	5.1

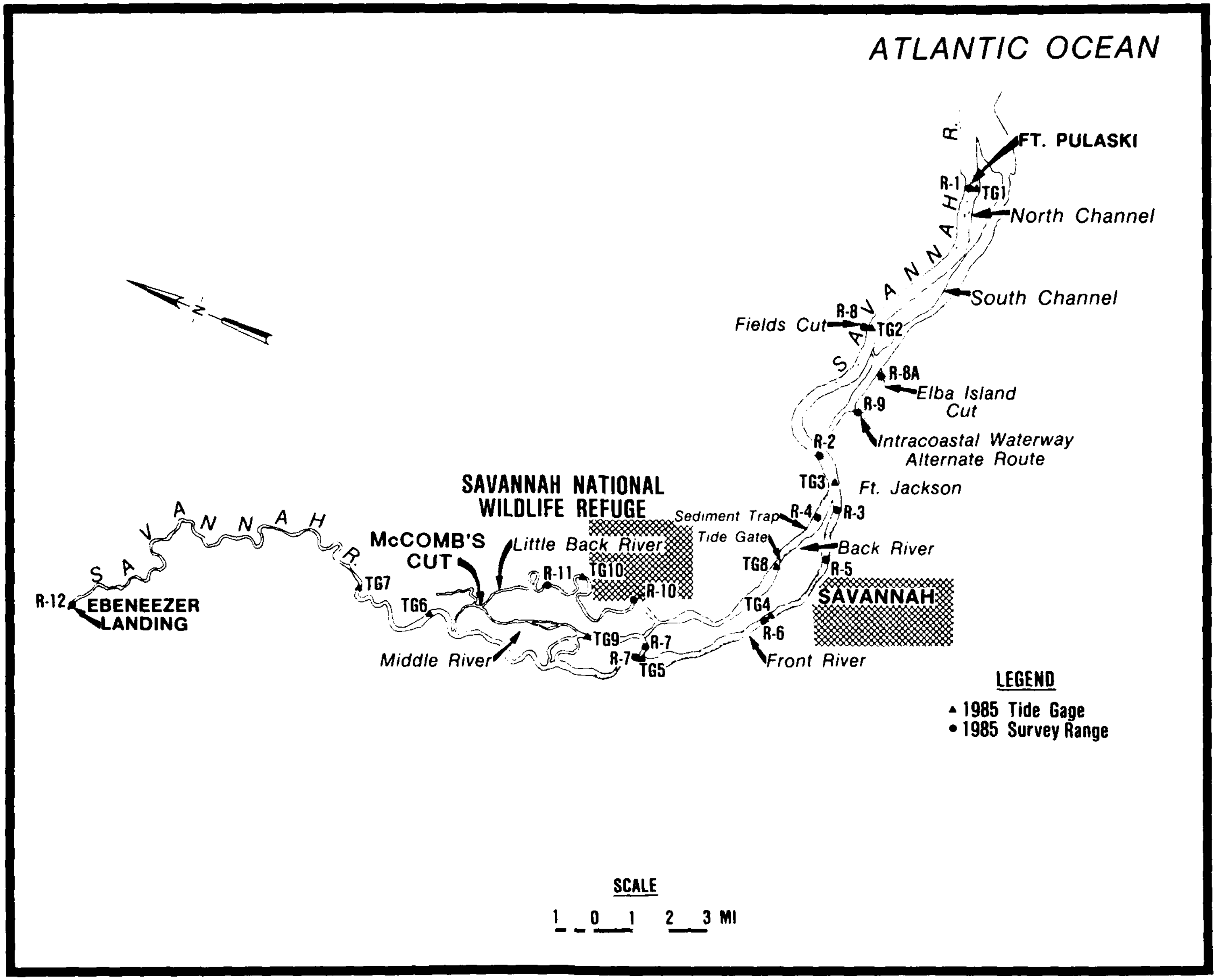


Figure 1. Savannah Estuary

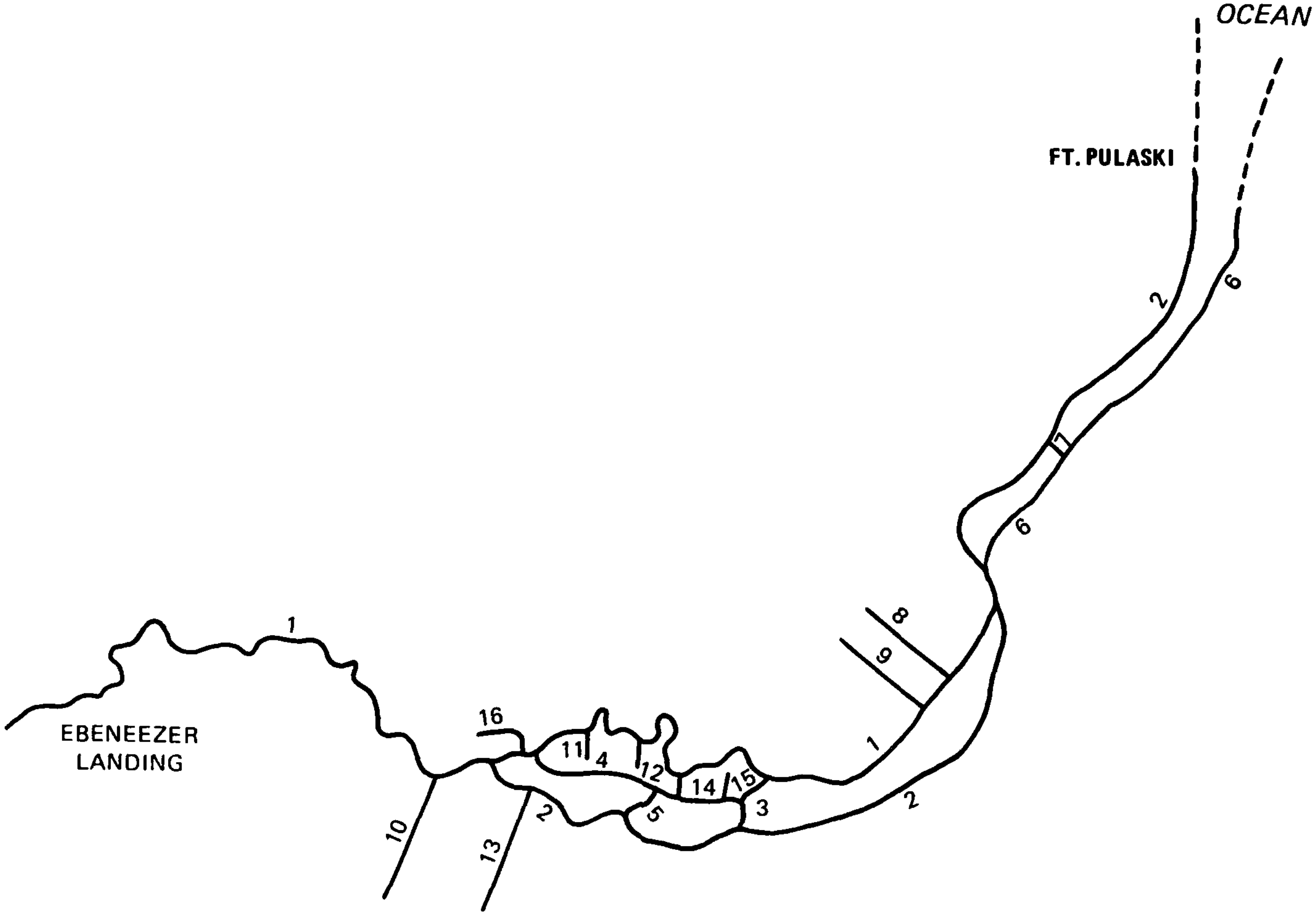


Figure 2. Branch locations

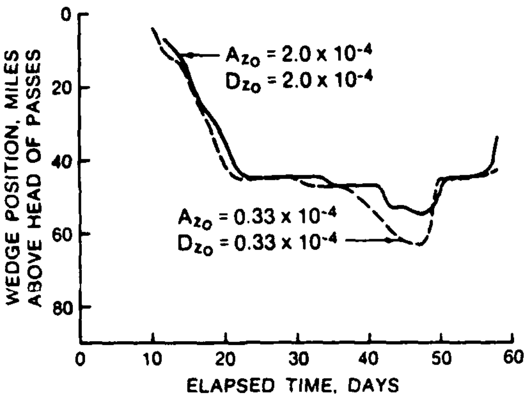


Figure 3. Effect of vertical diffusion coefficients on wedge intrusion in Lower Mississippi (from Johnson, Boyd, and Keulegan 1987)

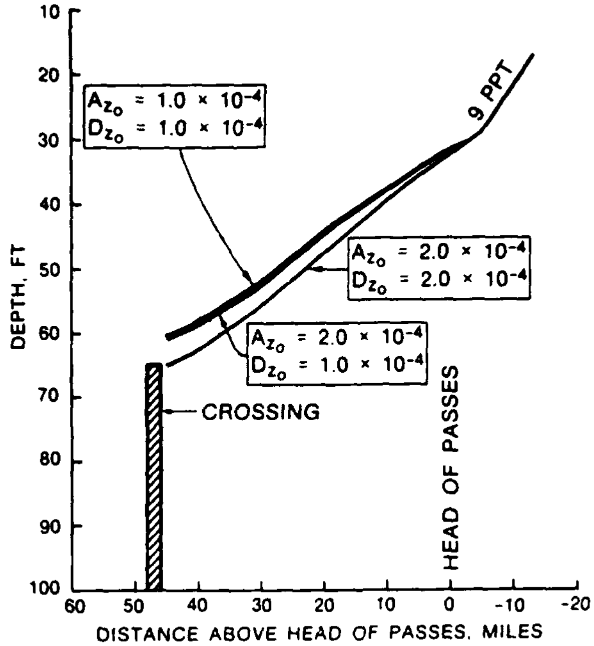


Figure 4. Effect of vertical diffusion coefficients on wedge interface in Lower Mississippi (from Johnson, Boyd, and Keulegan 1987)

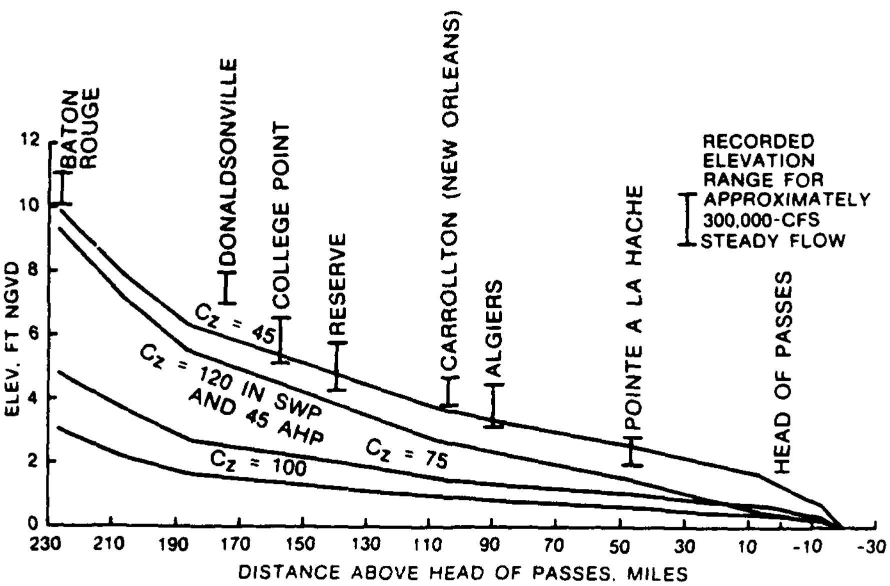


Figure 5. Effect of C_z on water-surface profile in Lower Mississippi (from Johnson, Boyd, and Keulegan 1987)

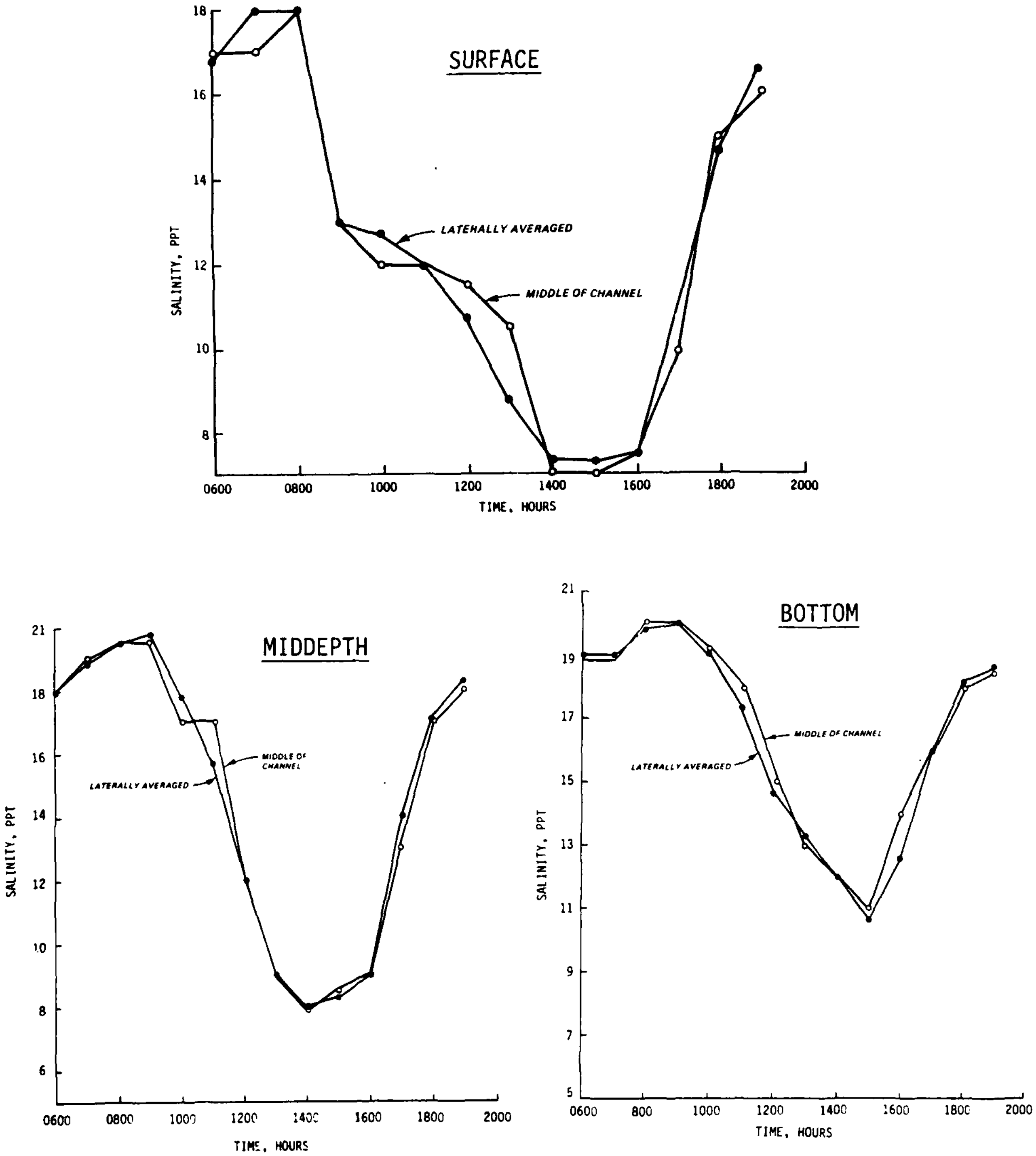


Figure 6. Salinities at Range 2

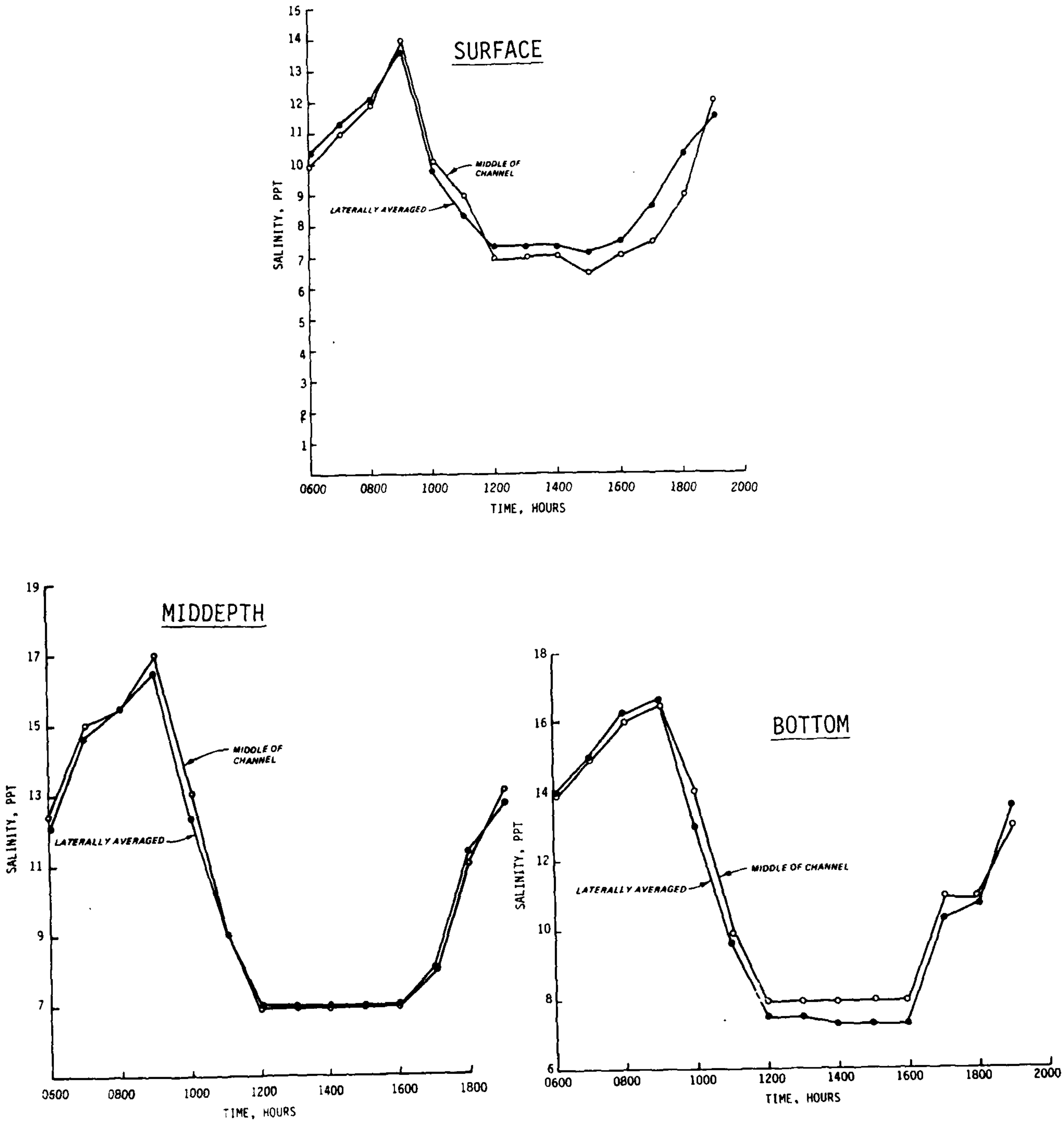


Figure 7. Salinity at Range 5

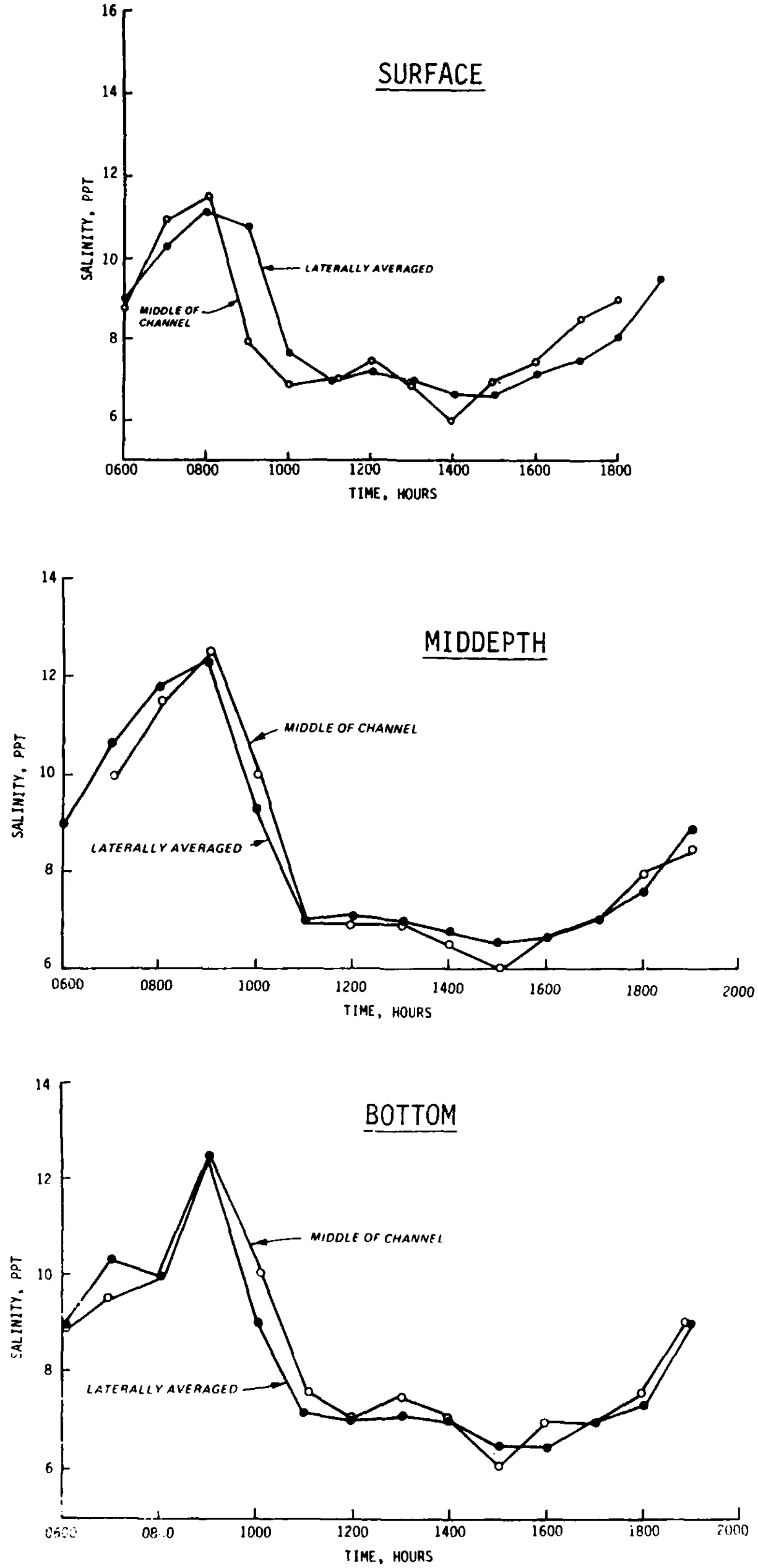


Figure 8. Salinity at Range 6

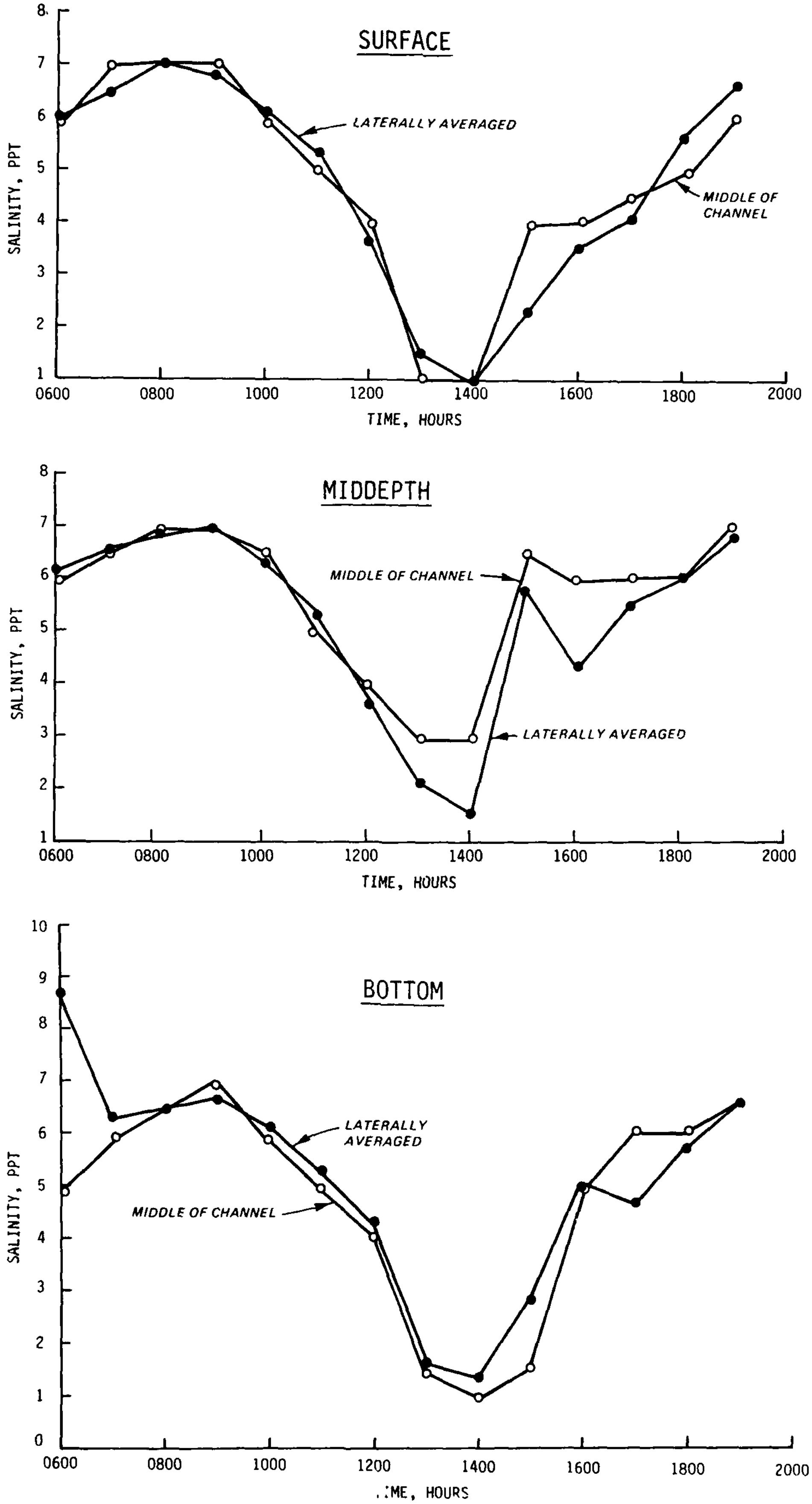


Figure 9. Salinity at Range 7

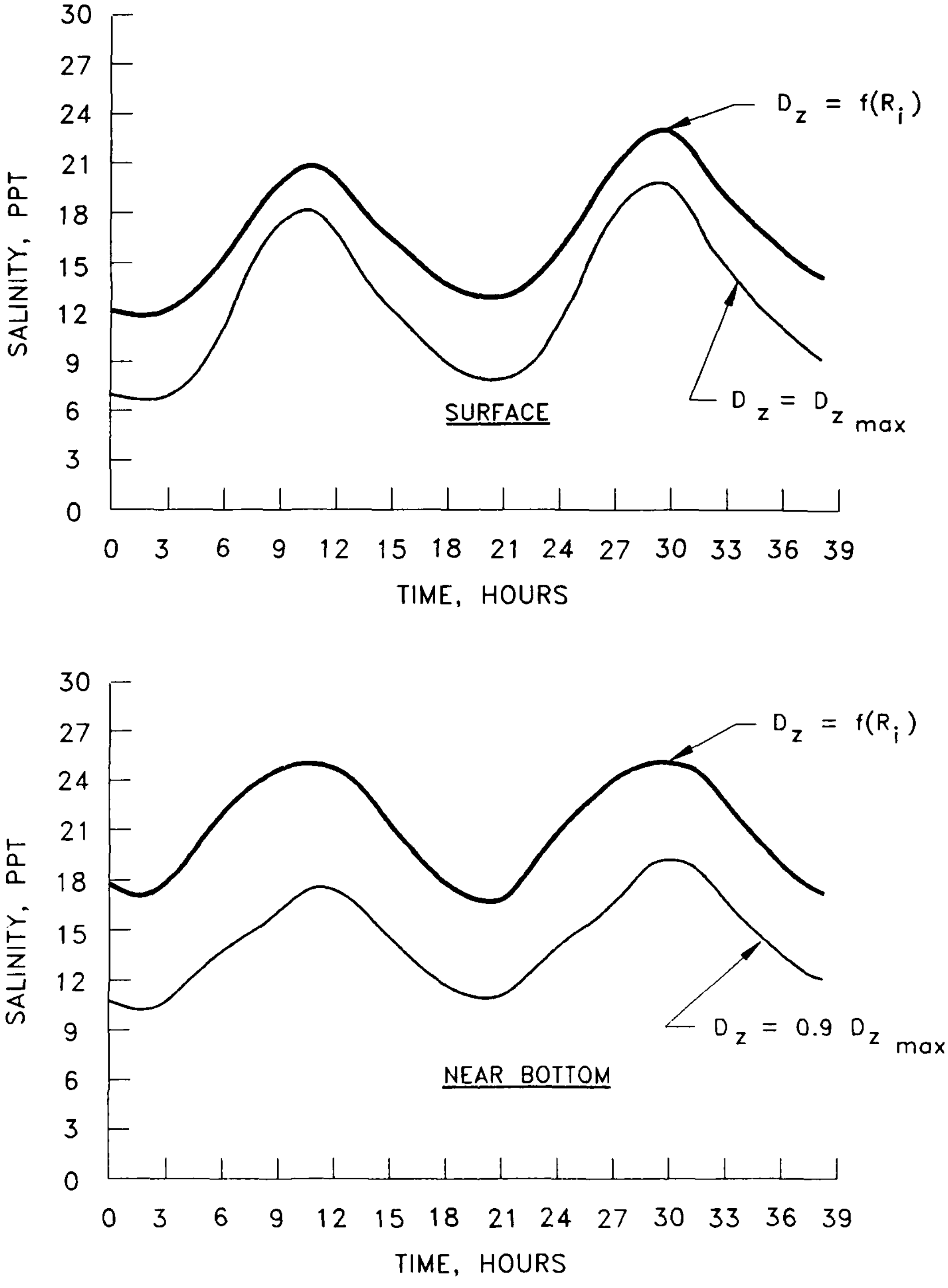


Figure 10. Effect of D_z in the ocean on salinities at Fort Jackson

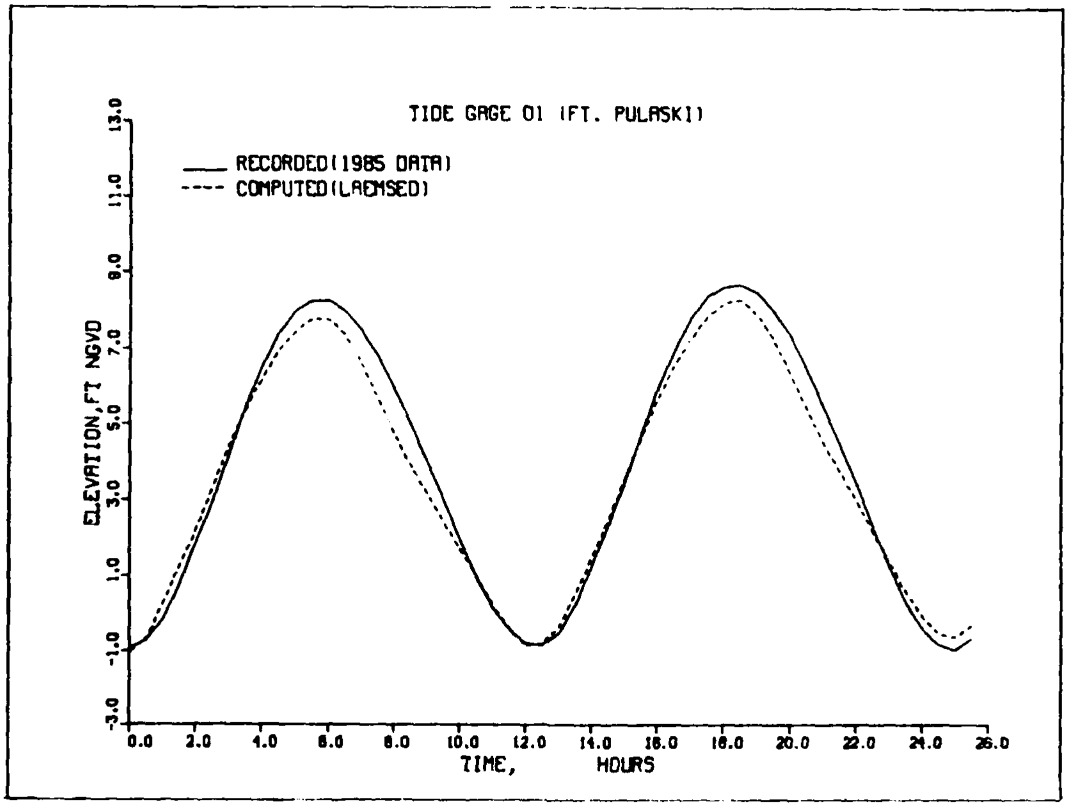


Figure 11. Comparison of computed and recorded tide at Fort Pulaski

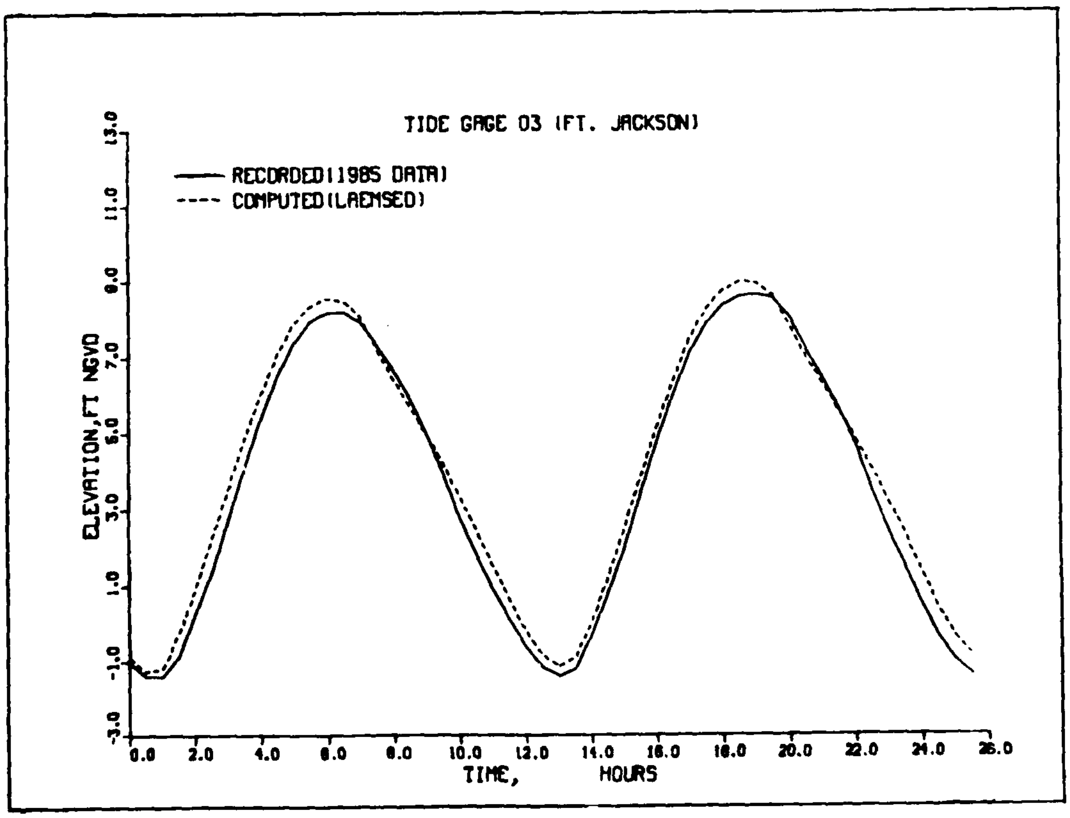


Figure 12. Comparison of computed and recorded tide at Fort Jackson

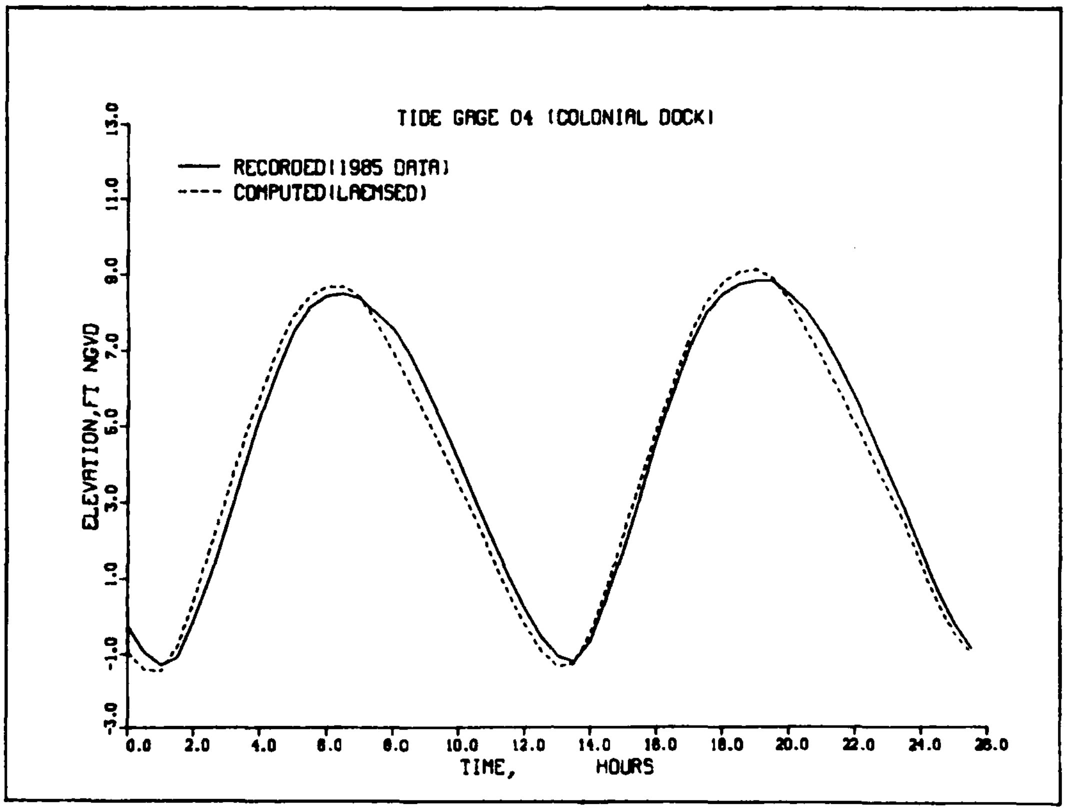


Figure 13. Comparison of computed and recorded tide at Colonial Dock

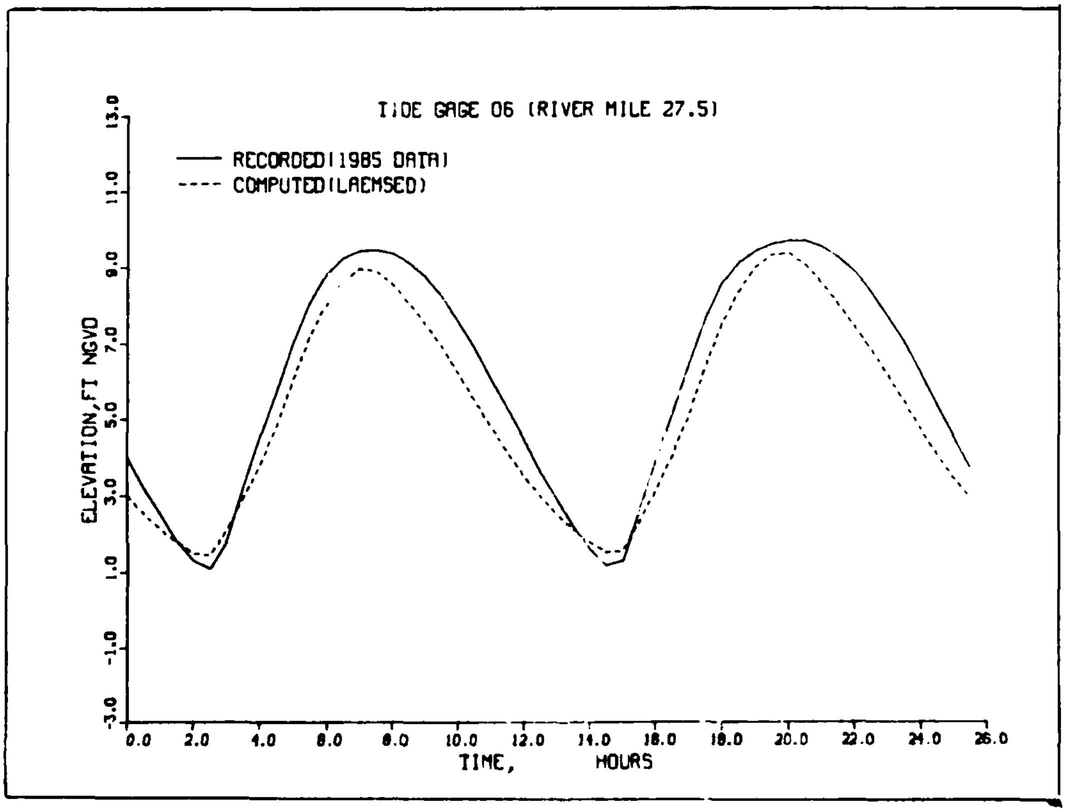


Figure 14. Comparison of computed and recorded tide at mile 27.5

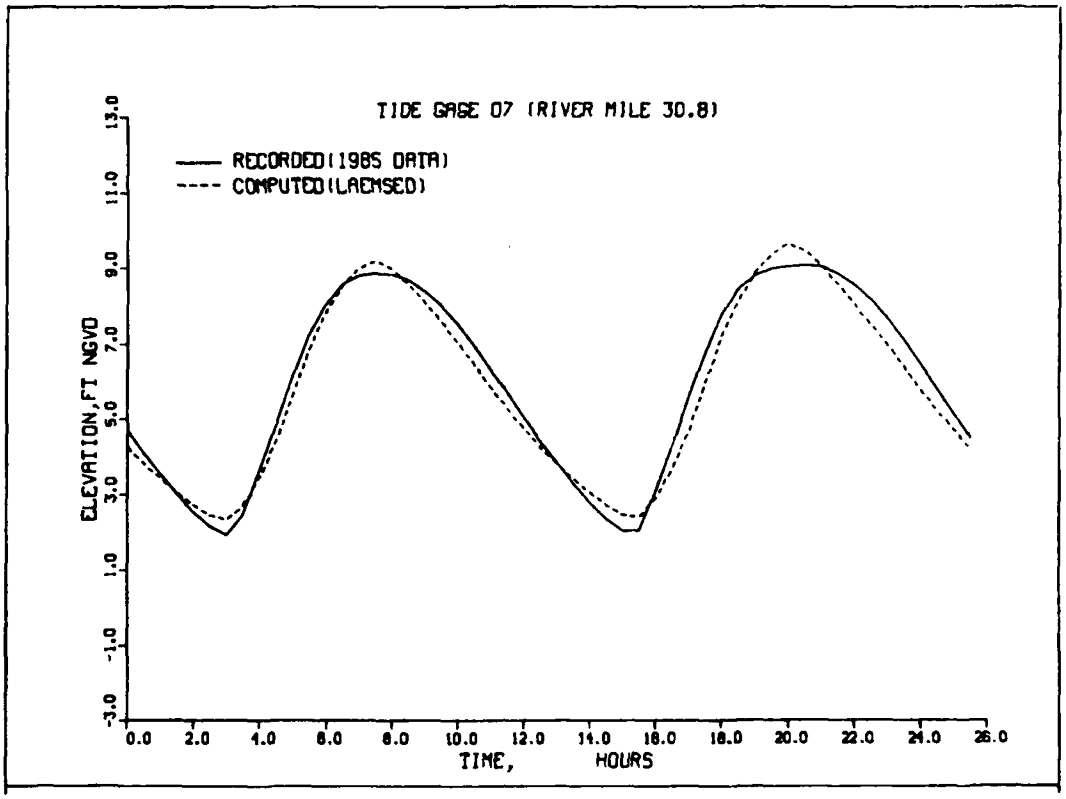


Figure 15. Comparison of computed and recorded tide at mile 30.8

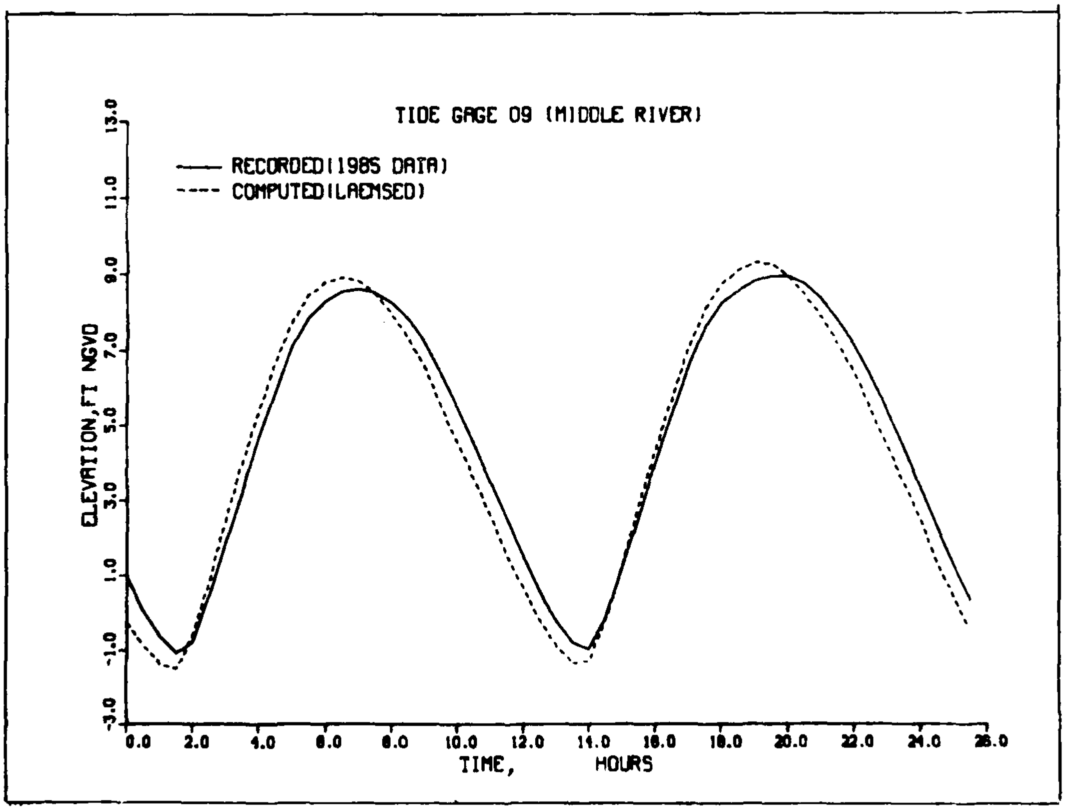


Figure 16. Comparison of computed and recorded tide on Middle River

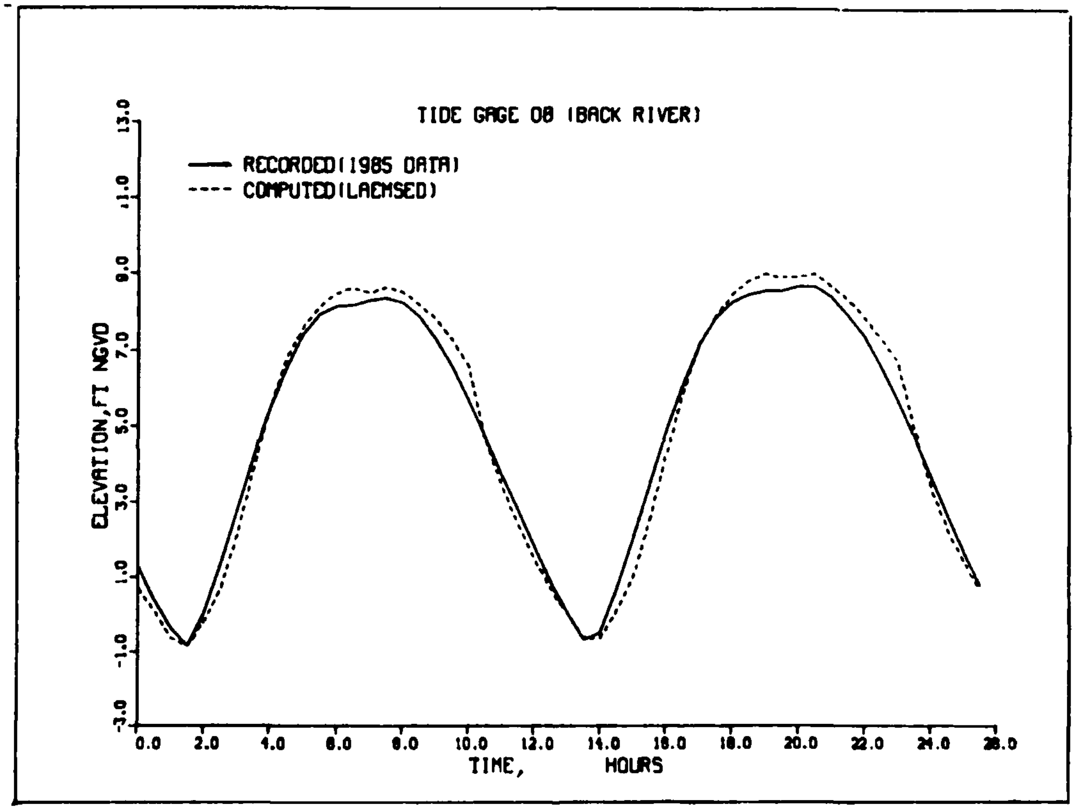


Figure 17. Comparison of computed and recorded tide on Back River

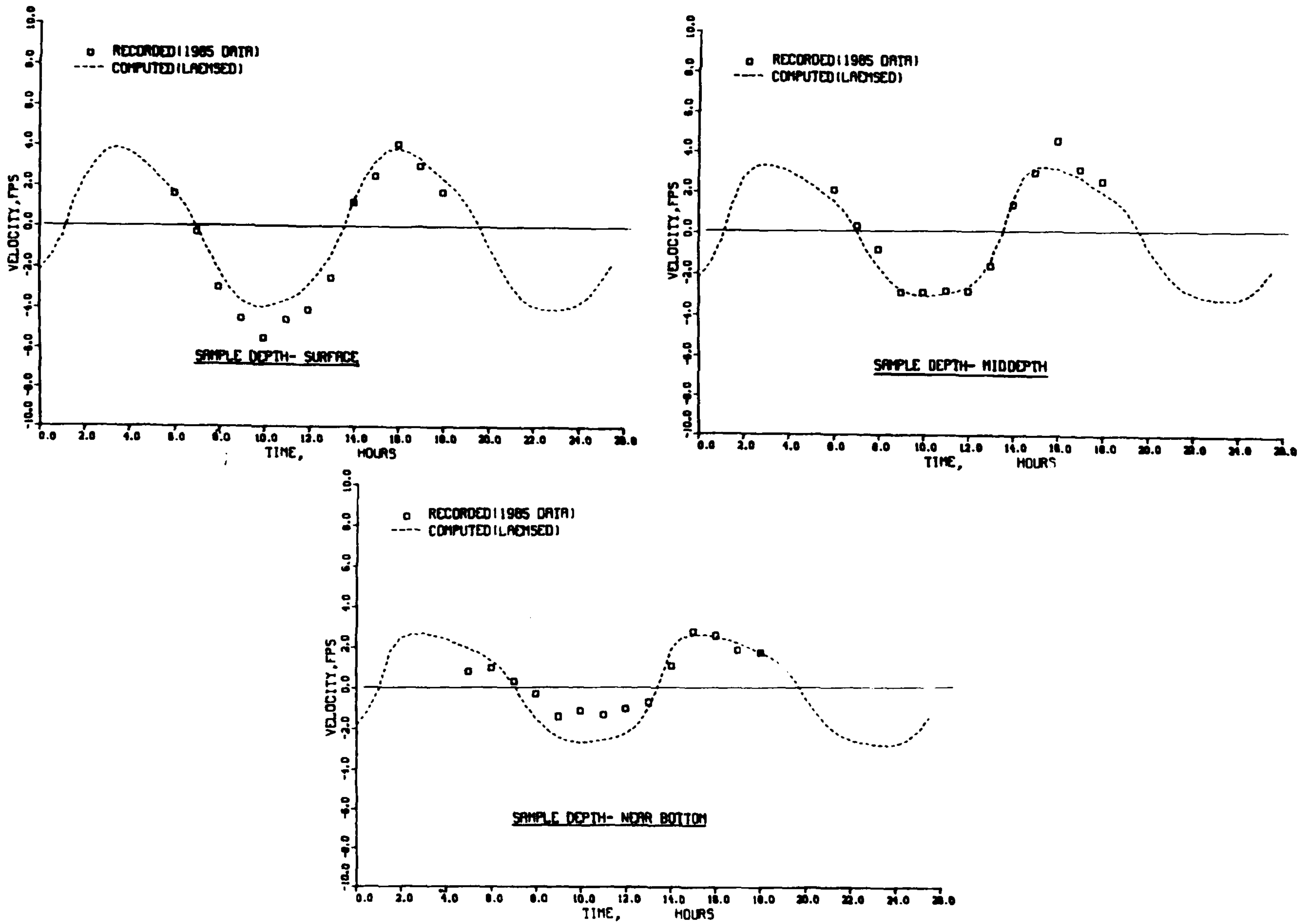


Figure 18. Comparison of computed and recorded velocity at Fort Pulaski

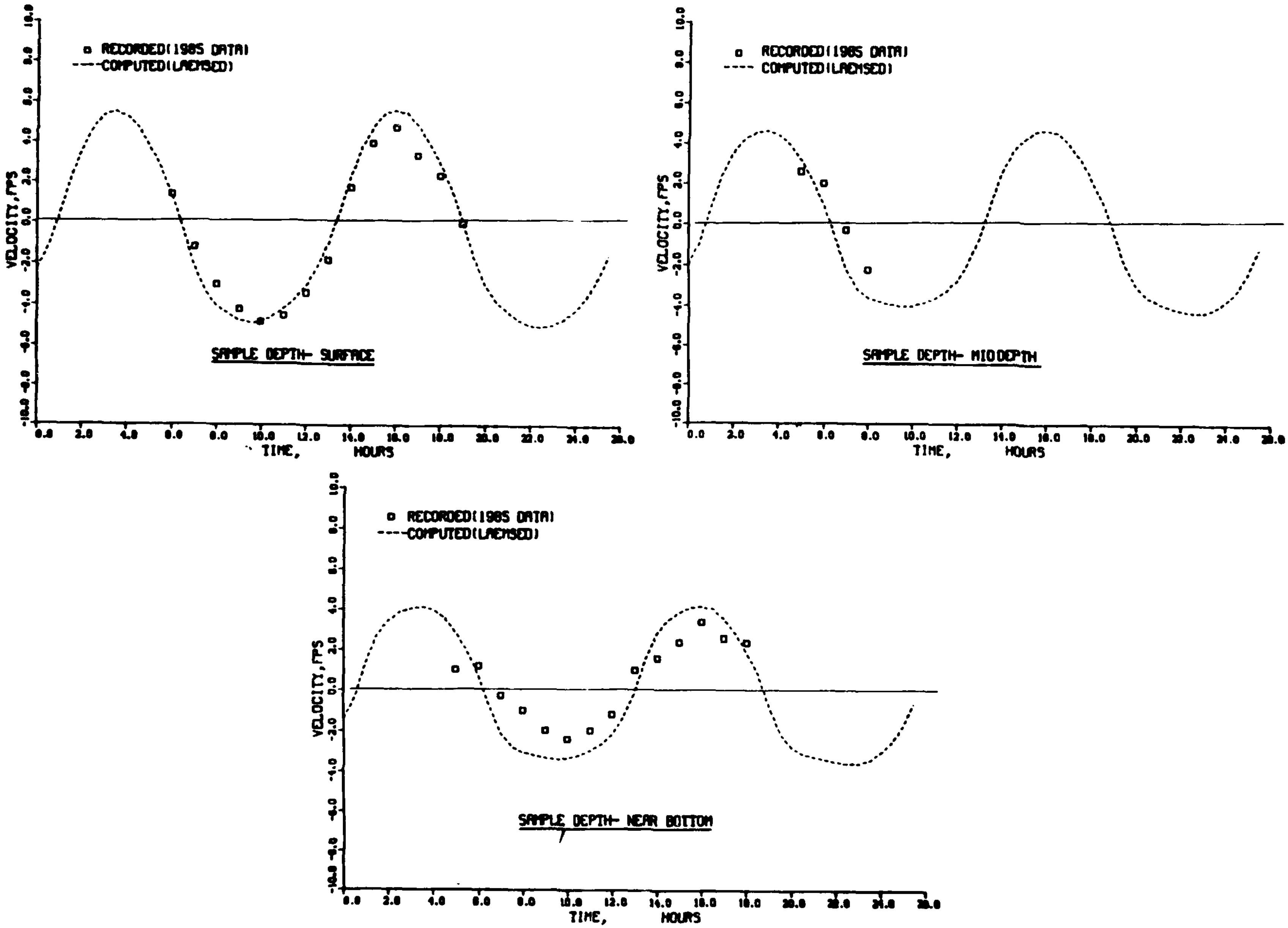


Figure 19. Comparison of computed and recorded velocity at Fort Jackson

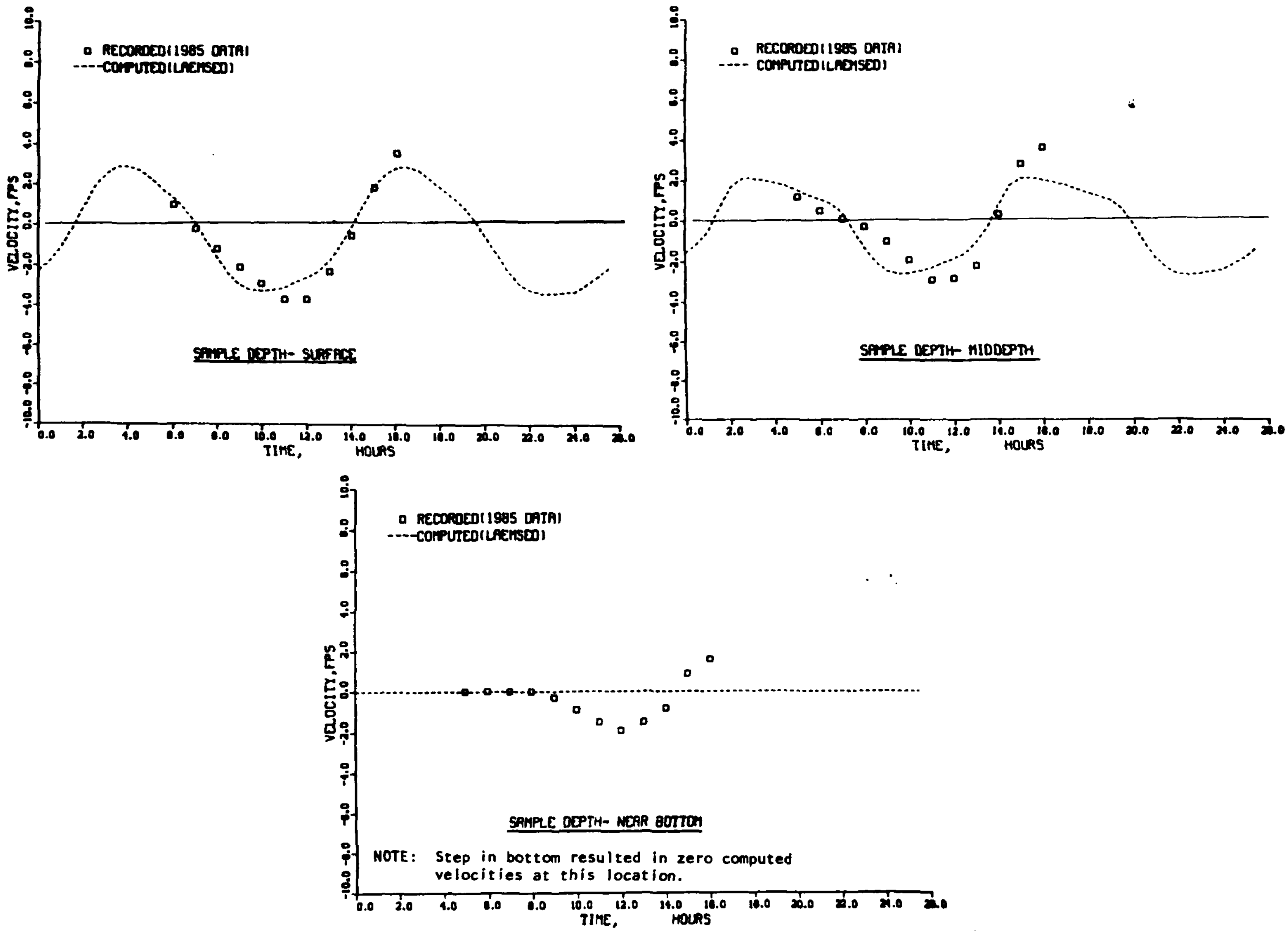


Figure 20. Comparison of computed and recorded velocity at Oglethorpe

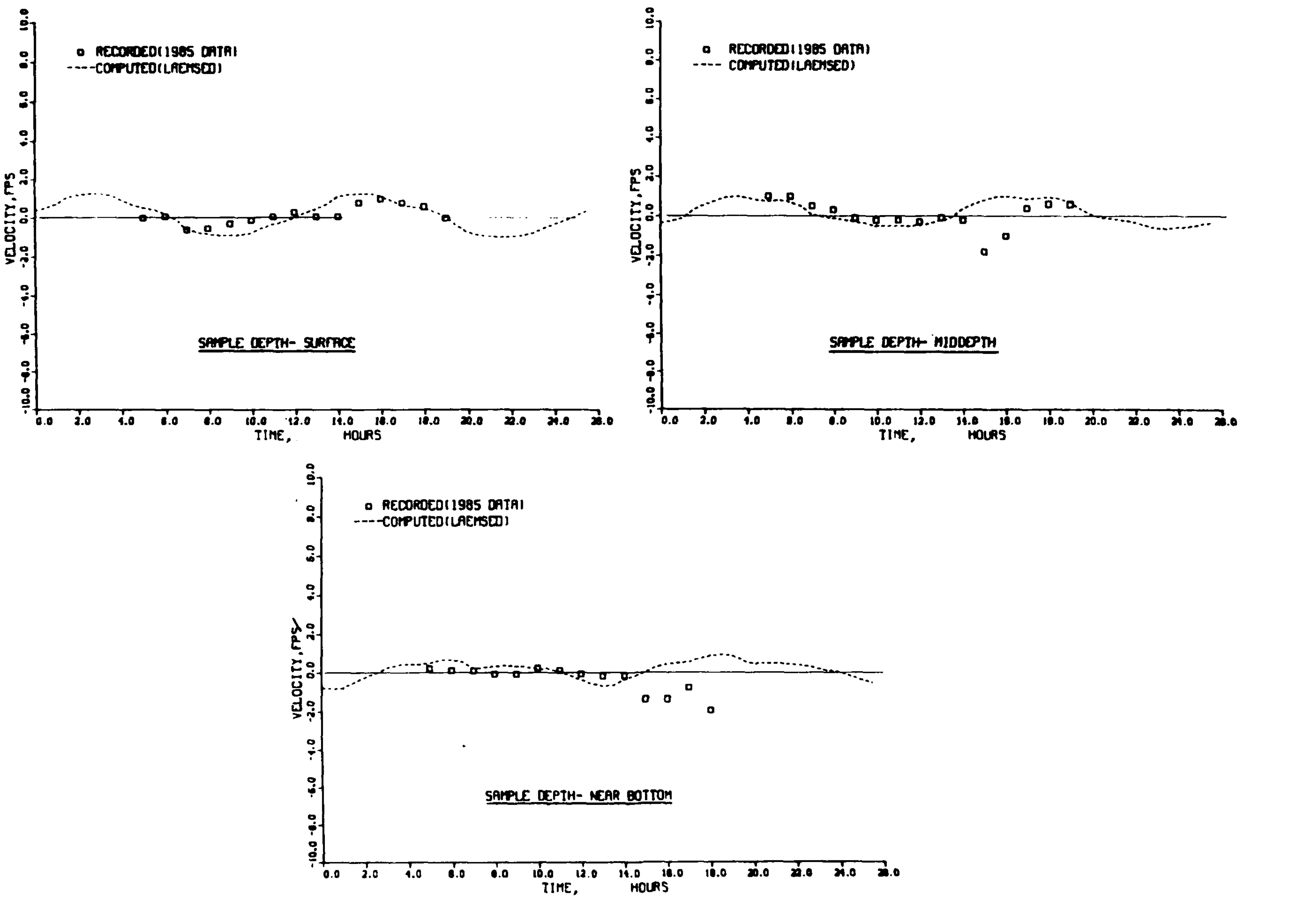


Figure 21. Comparison of computed and recorded velocity in sediment trap

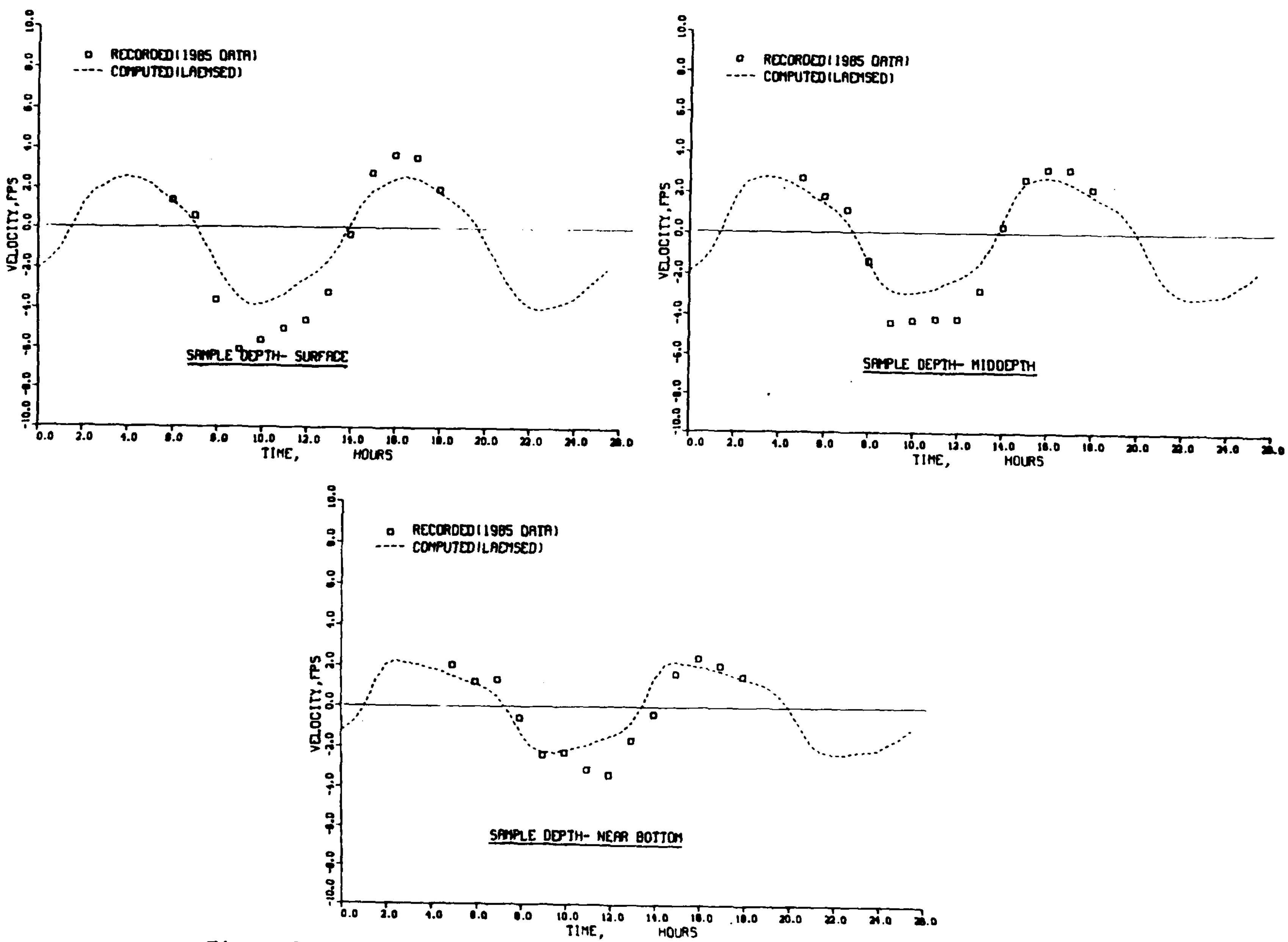


Figure 22. Comparison of computed and recorded velocity at City Front

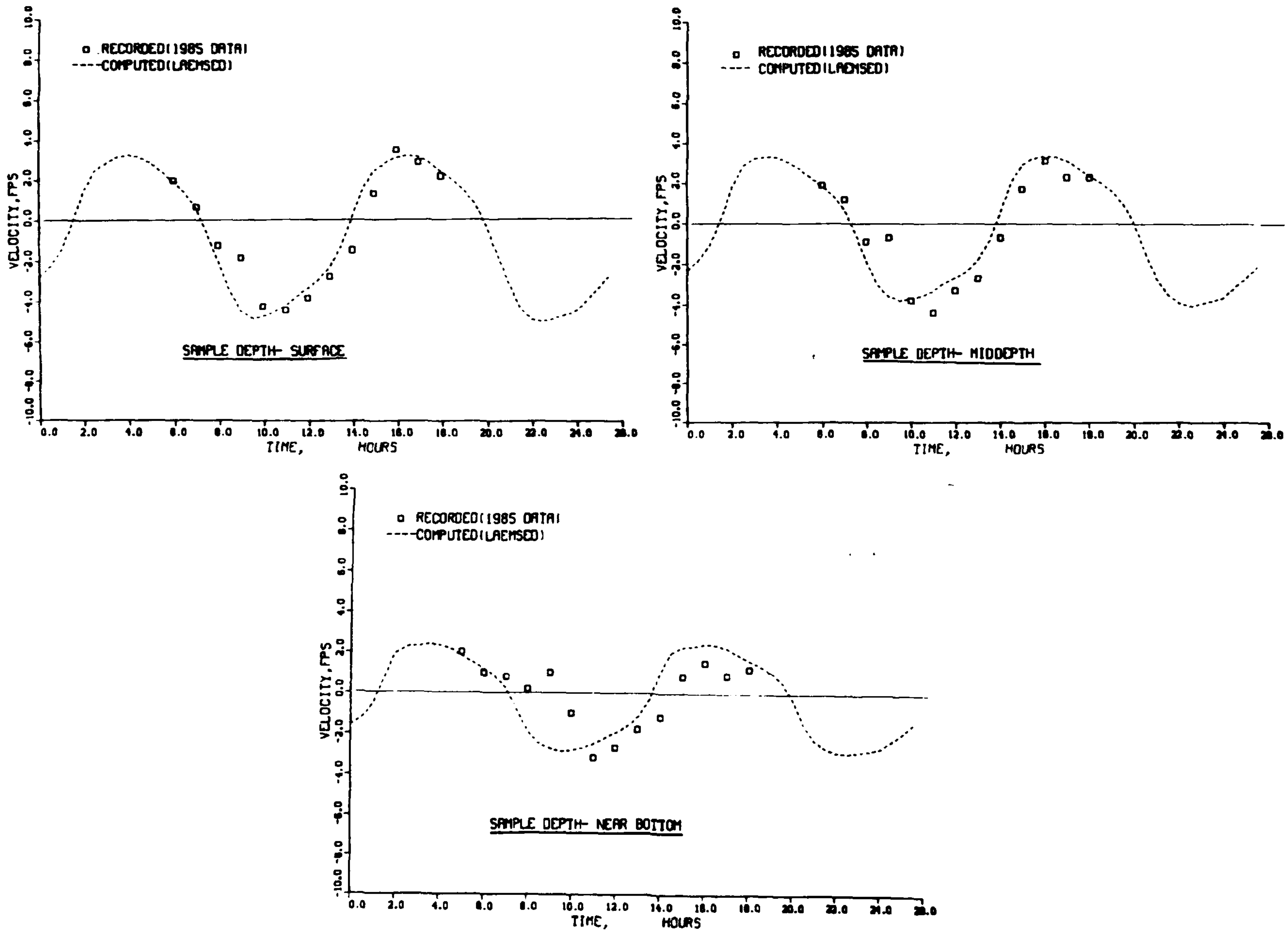


Figure 23. Comparison of computed and recorded velocity at Marsh Island

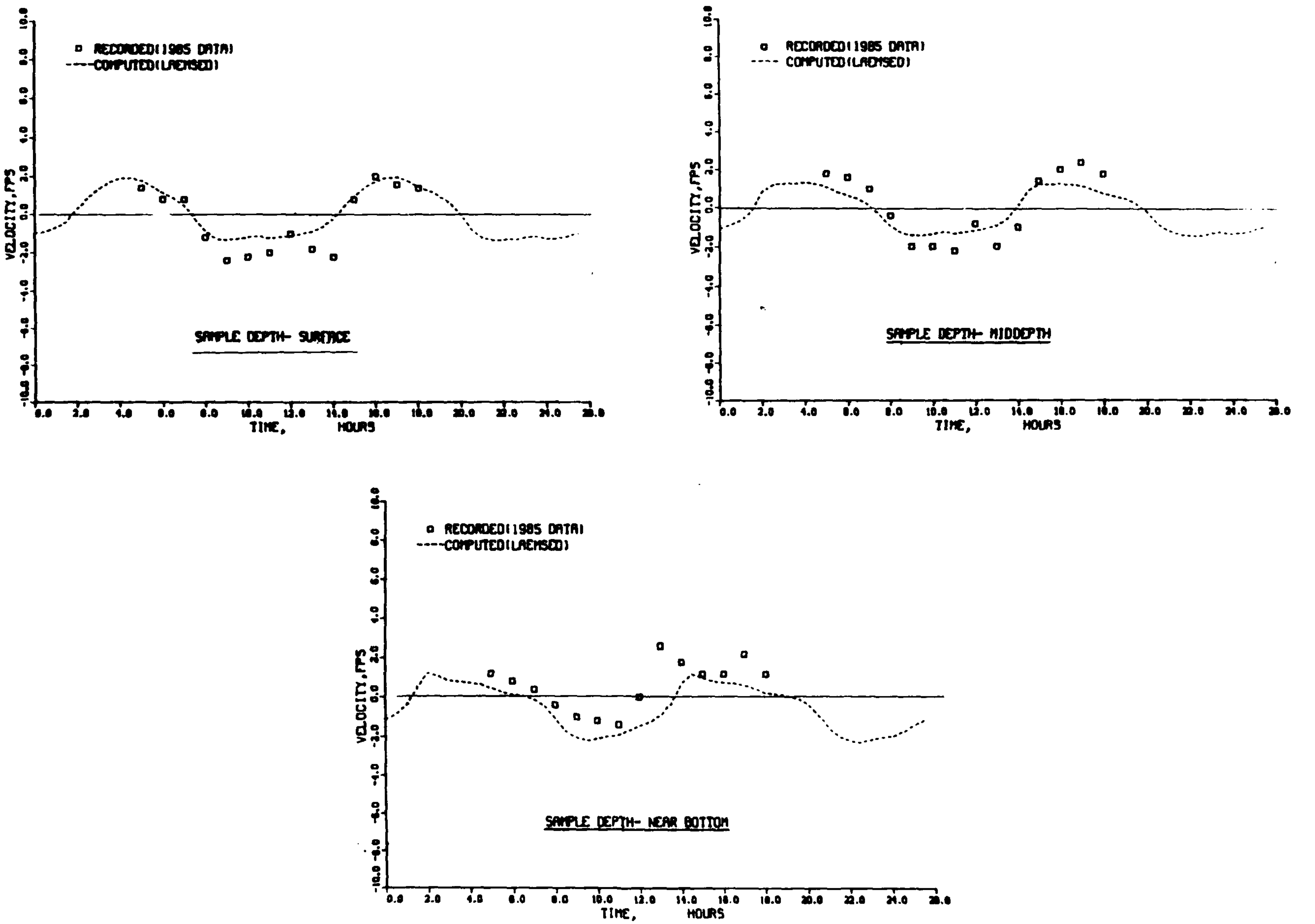


Figure 24. Comparison of computed and recorded velocity at Port Wentworth

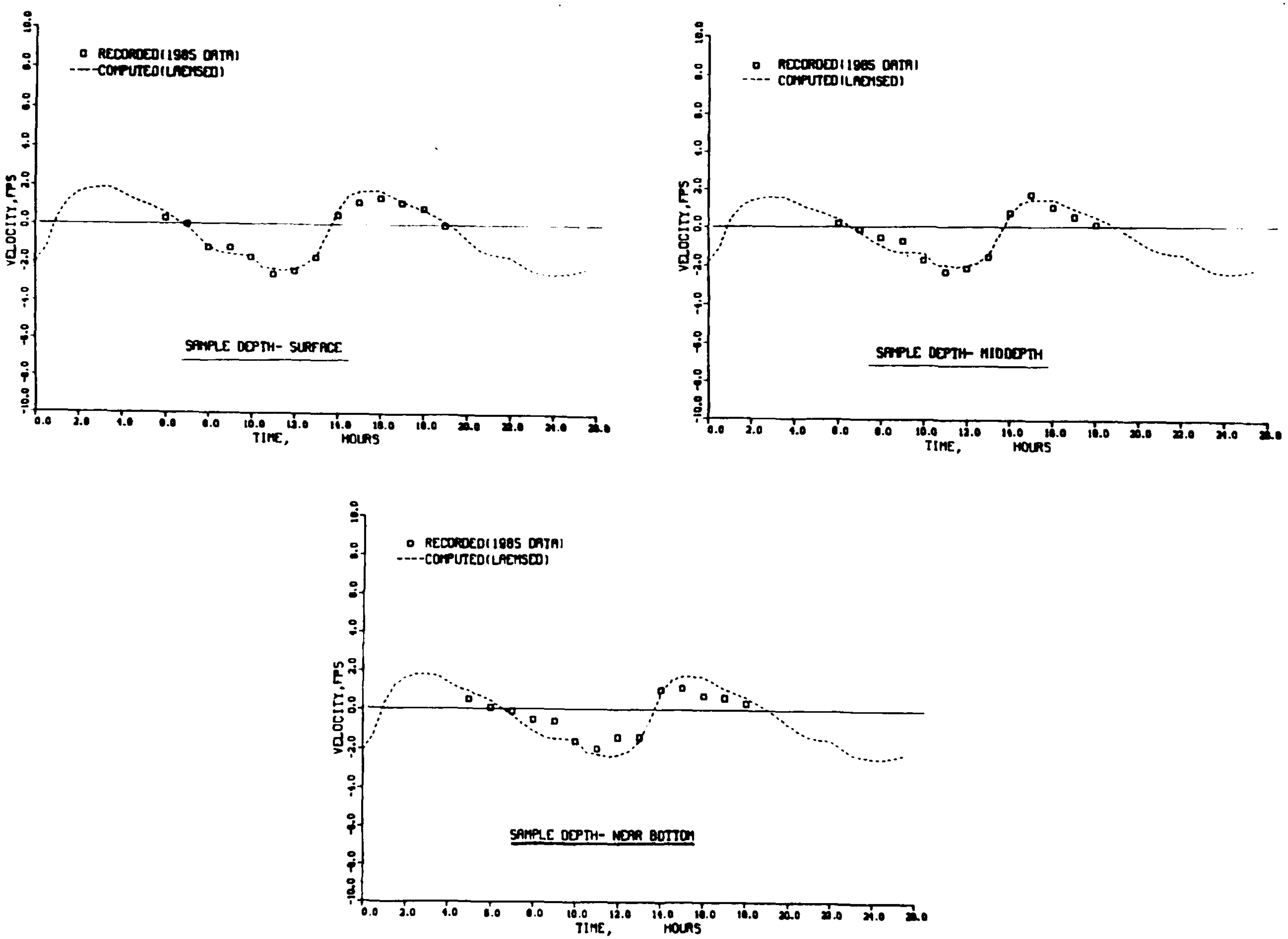


Figure 25. Comparison of computed and recorded velocity at Range 10

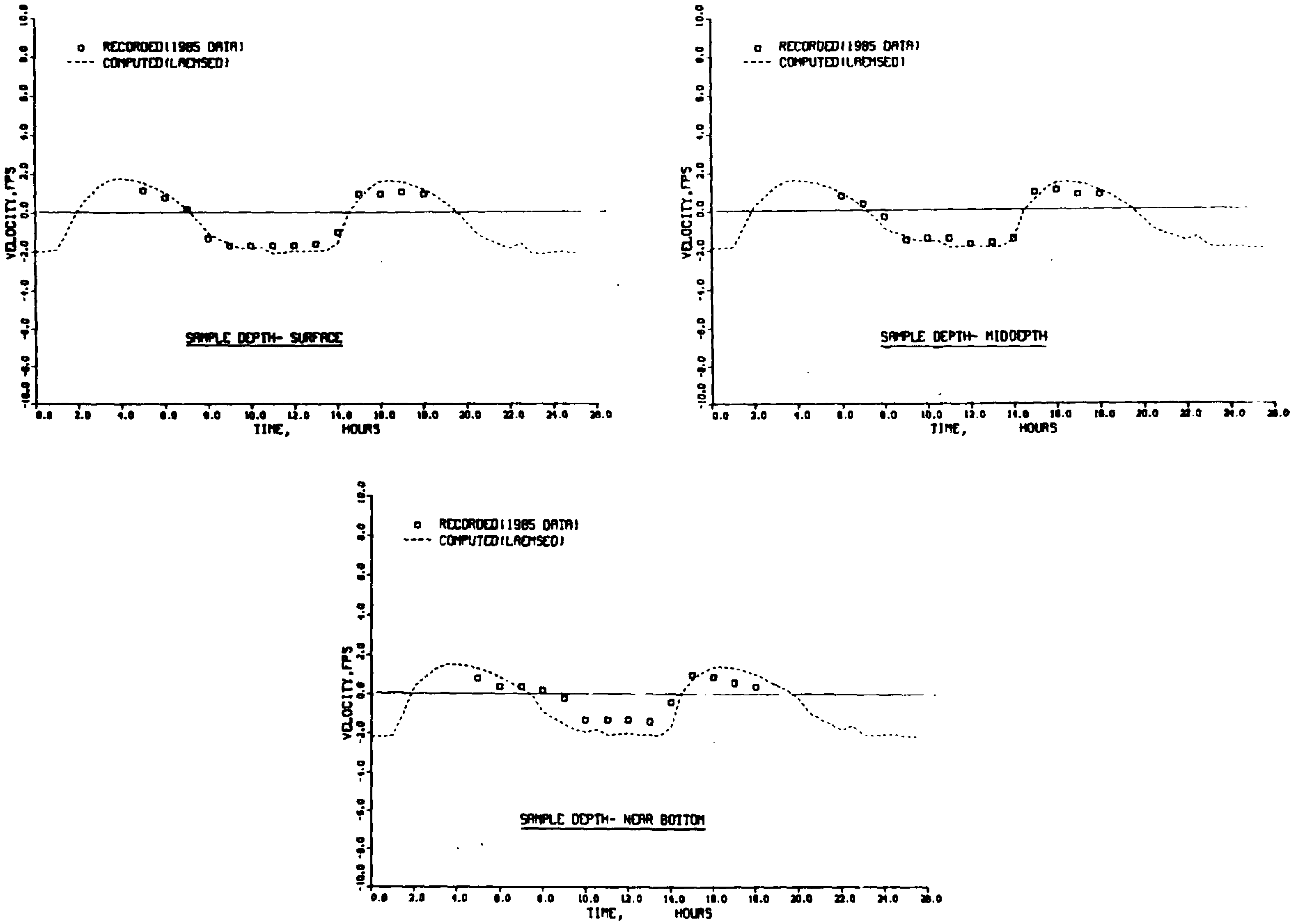


Figure 26. Comparison of computed and recorded velocity near Range 11

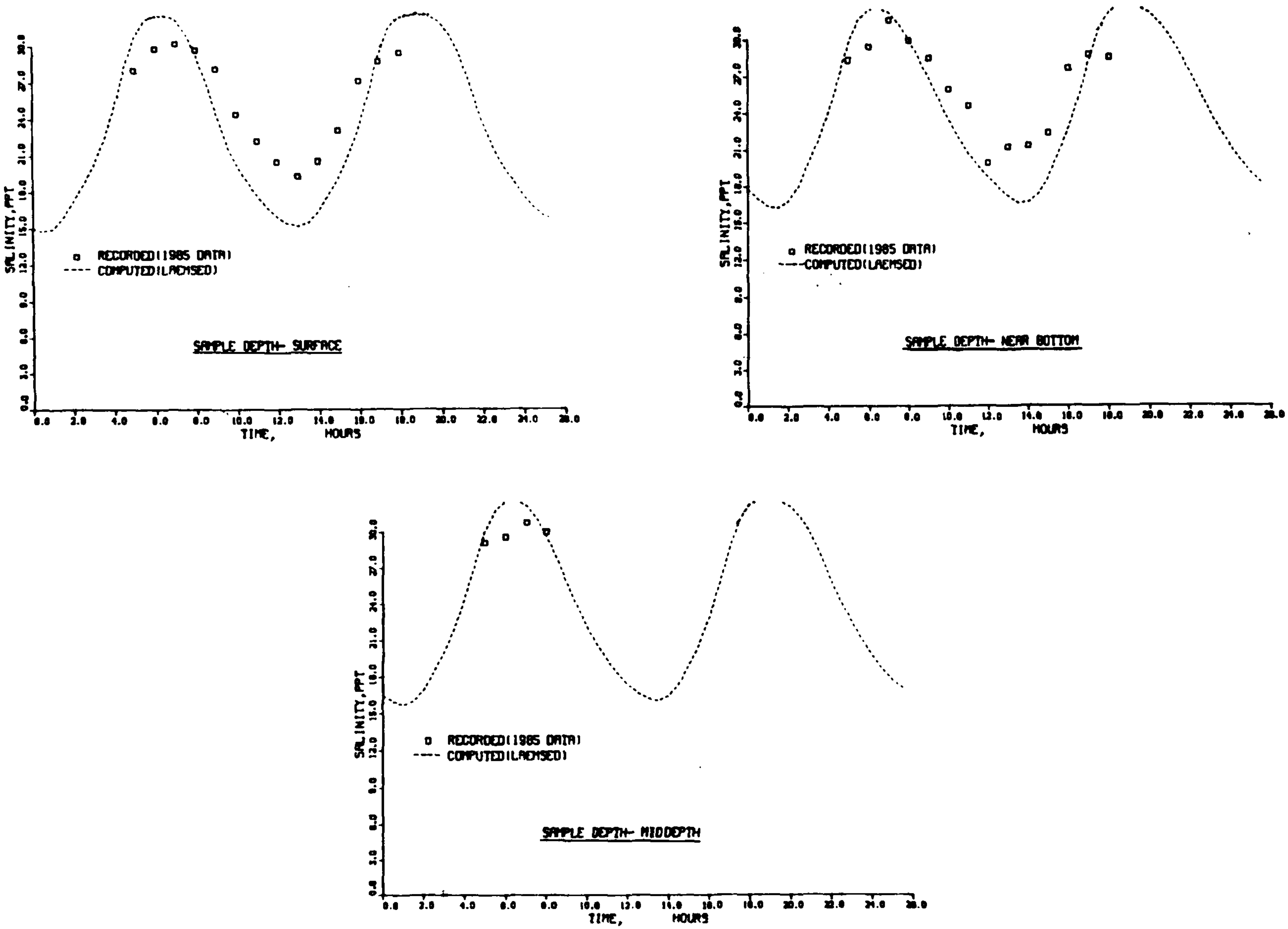


Figure 27. Comparison of computed and recorded salinity at Fort Pulaski

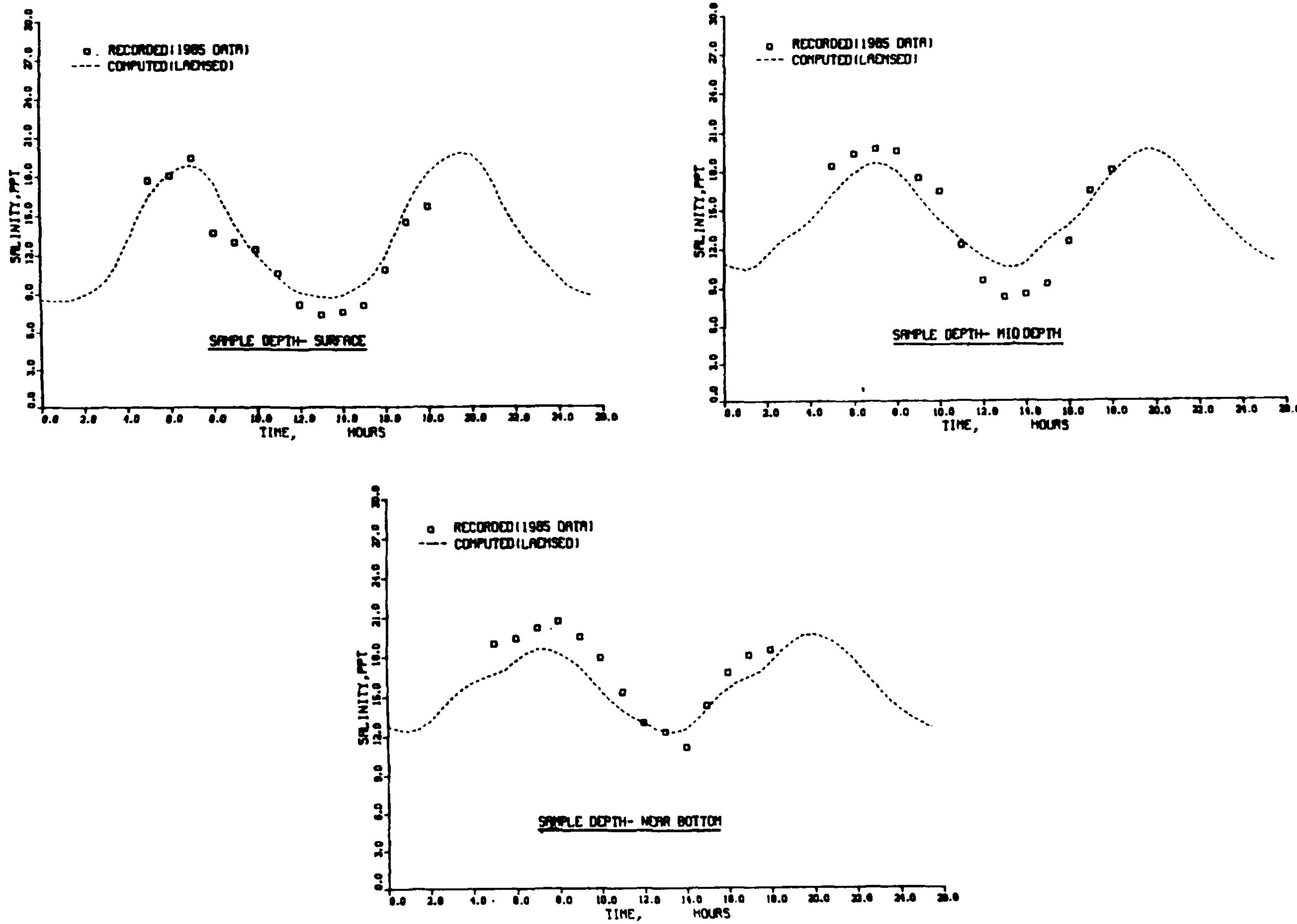


Figure 28. Comparison of computed and recorded salinity at Fort Jackson

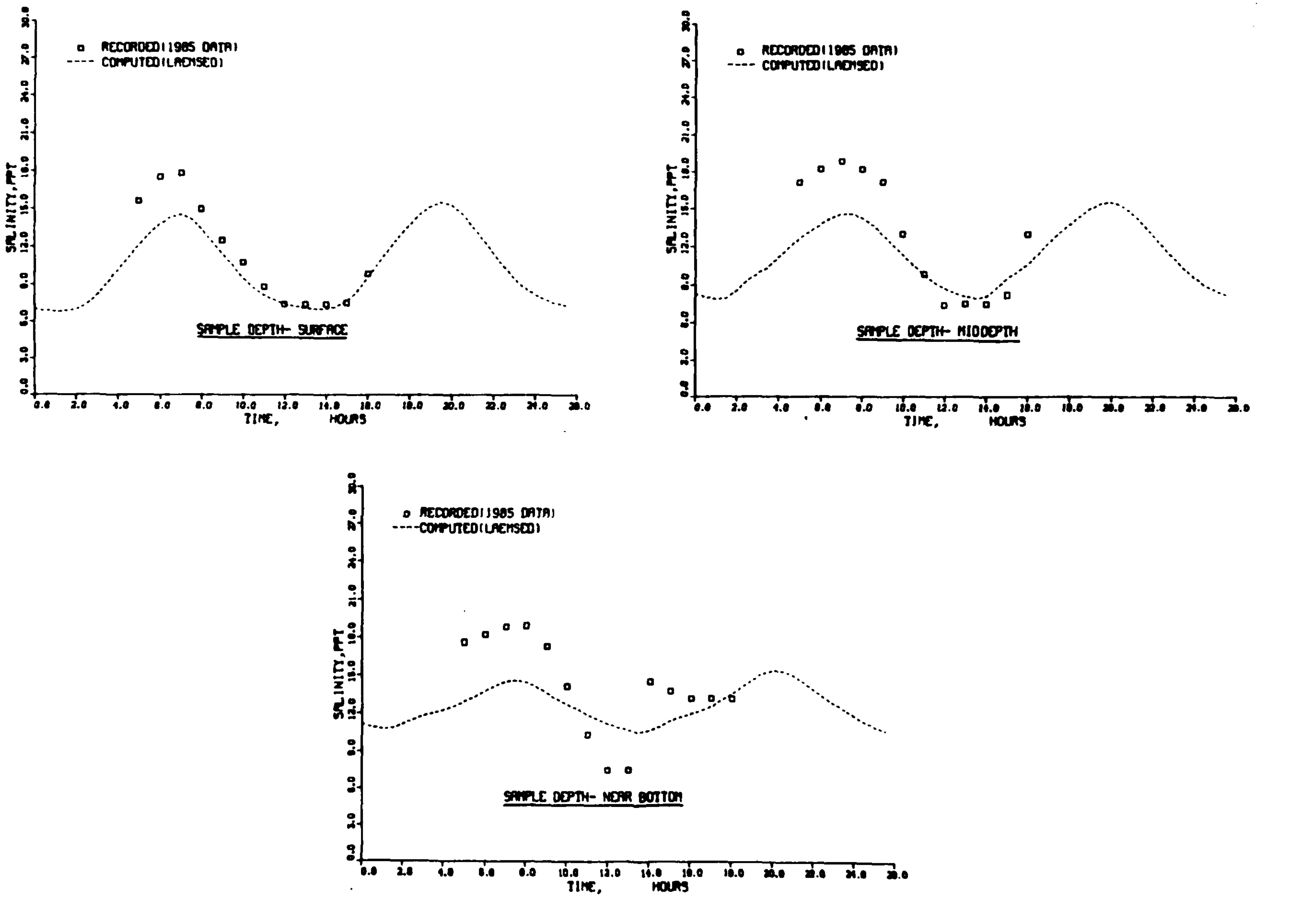


Figure 29. Comparison of computed and recorded salinity at Oglethorpe

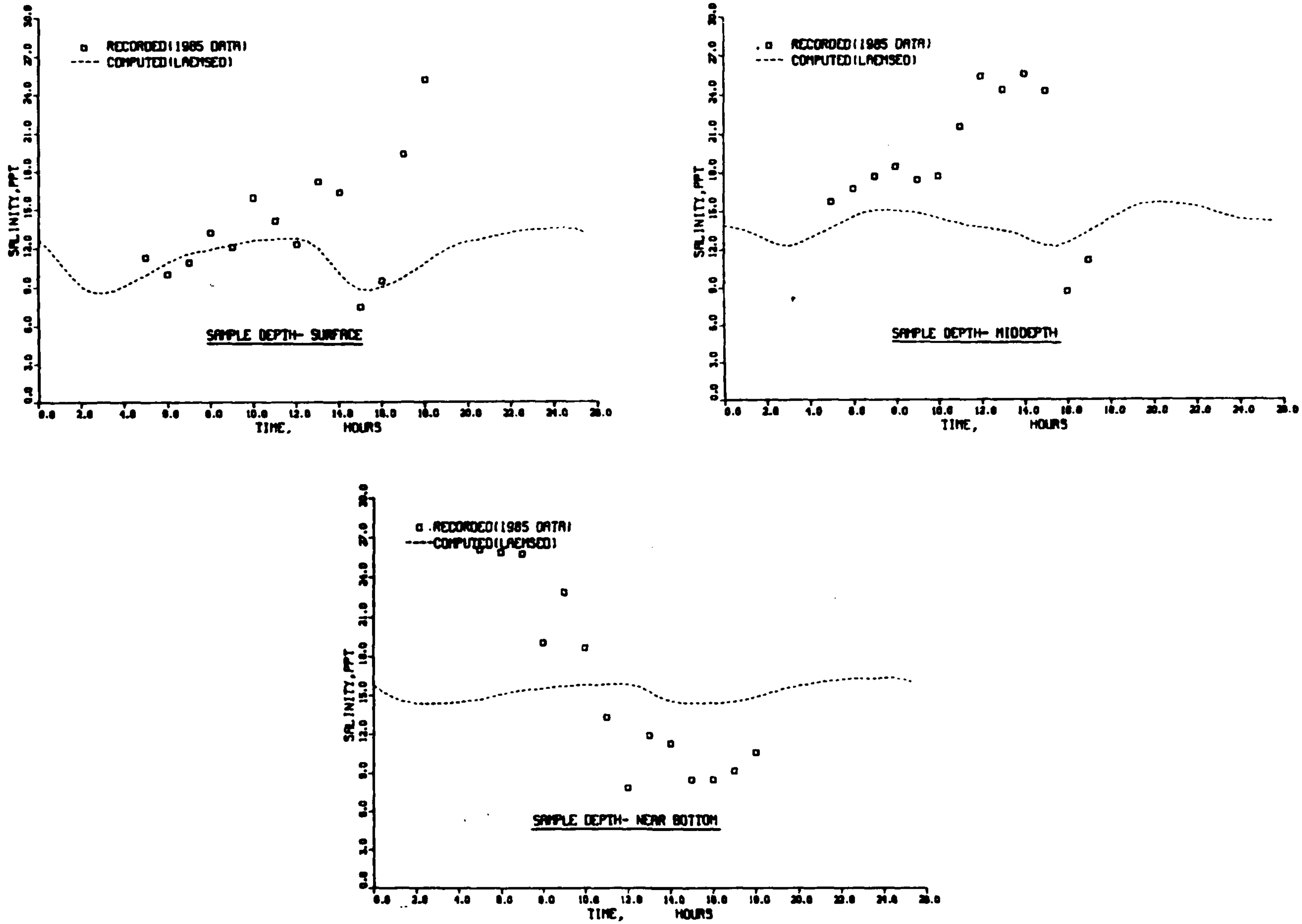


Figure 30. Comparison of computed and recorded salinity in sediment trap

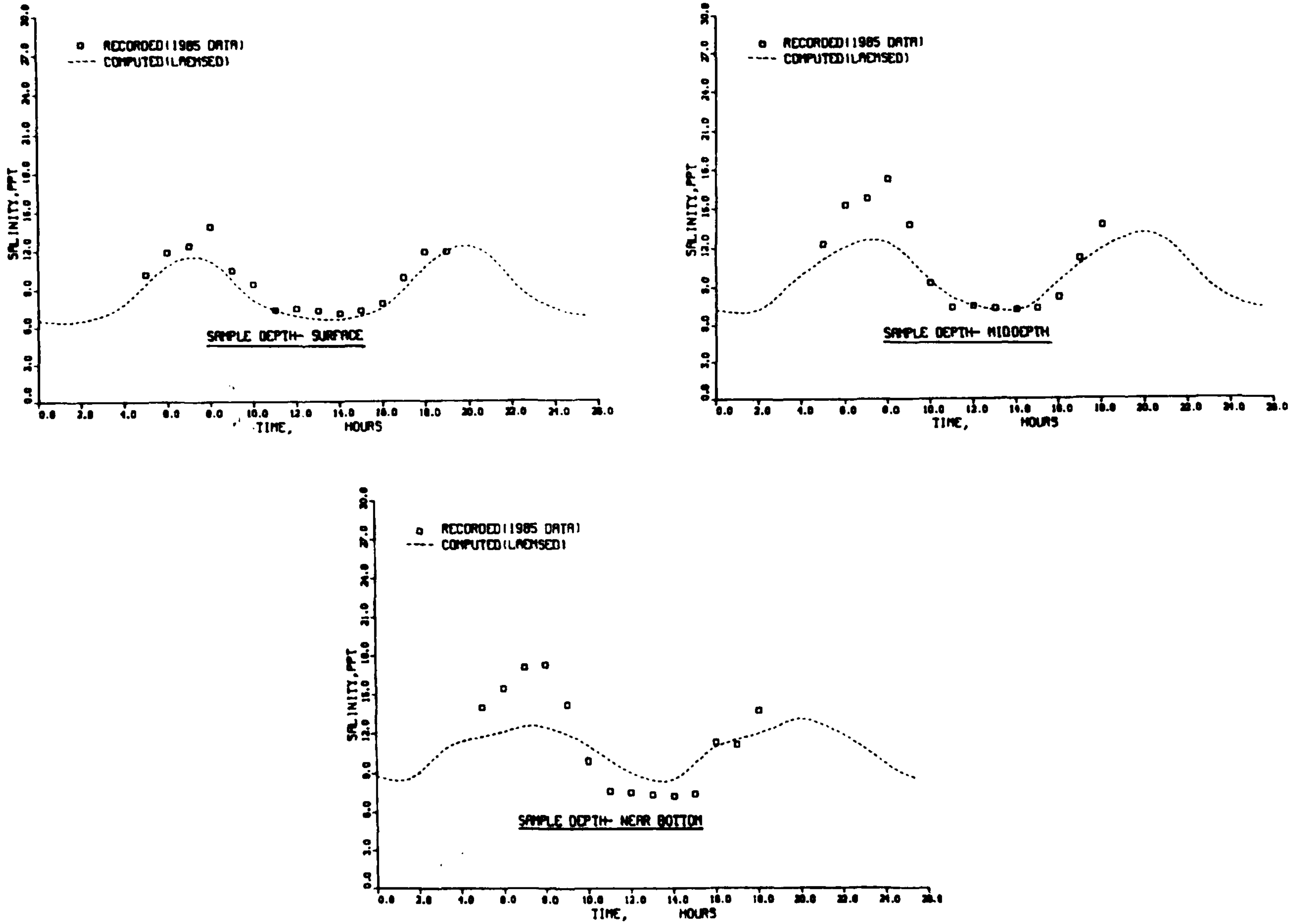


Figure 31. Comparison of computed and recorded salinity at City Front

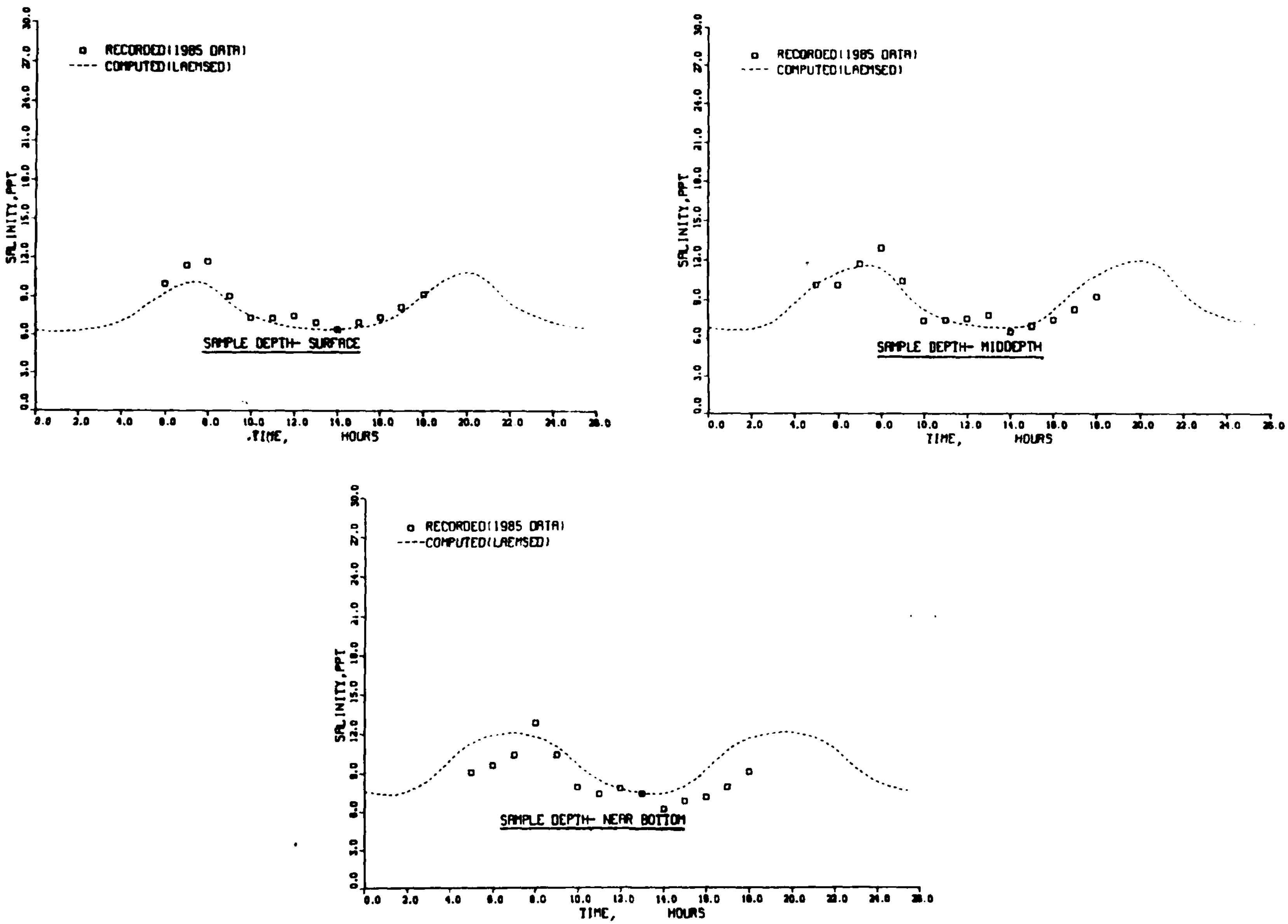


Figure 32. Comparison of computed and recorded salinity at Marsh Island

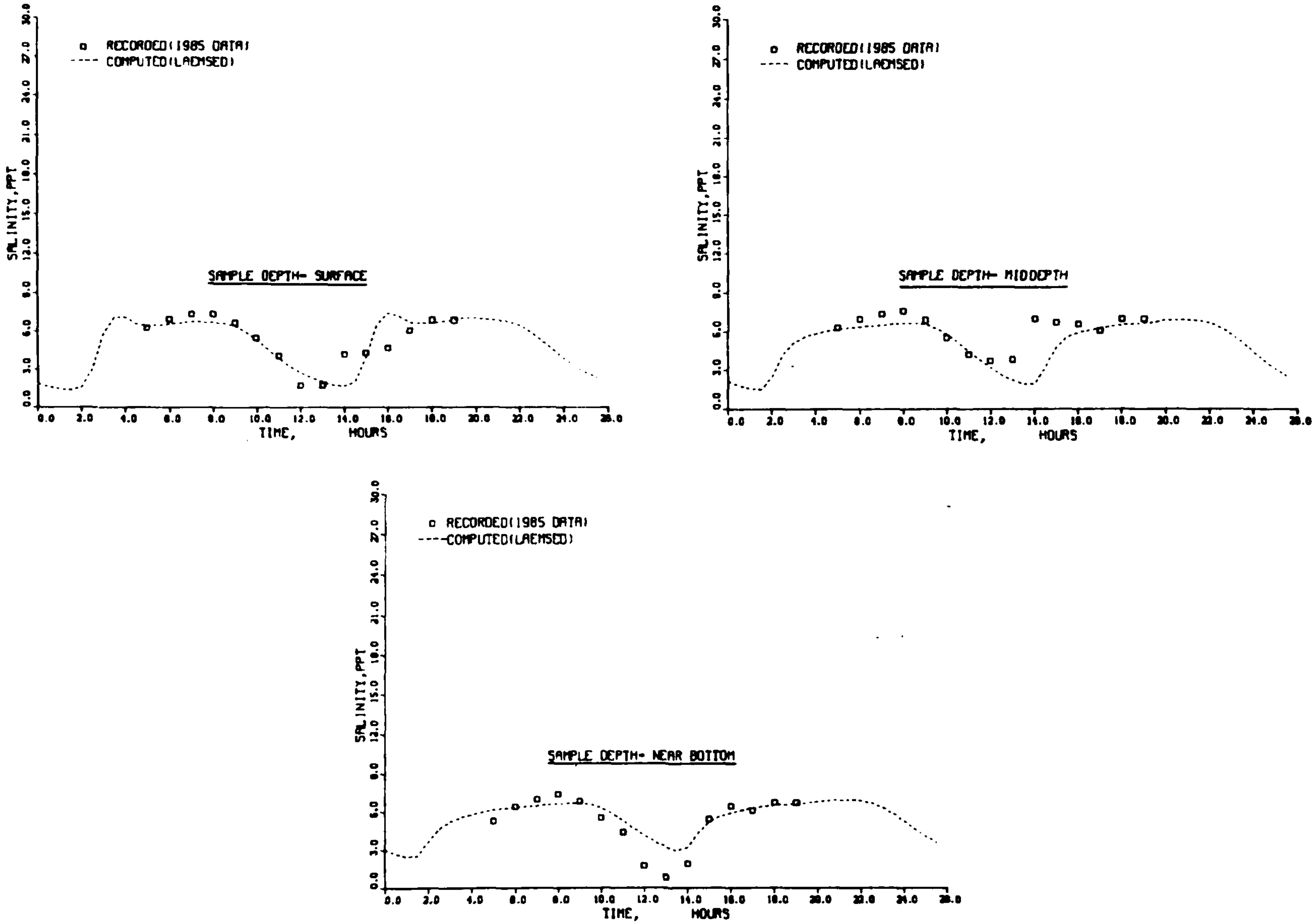


Figure 33. Comparison of computed and recorded salinity at Port Wentworth

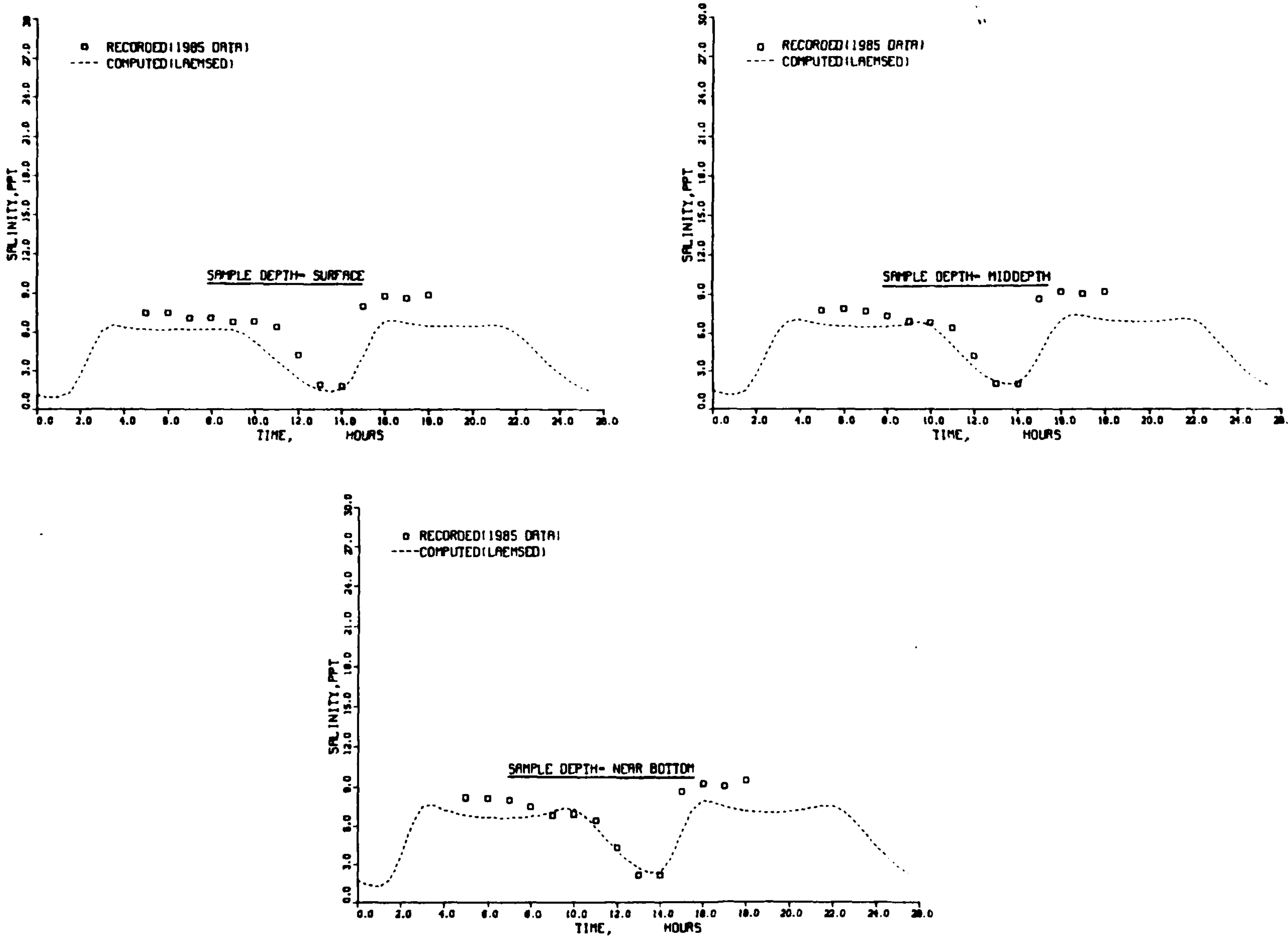


Figure 34. Comparison of computed and recorded salinity at Range 10

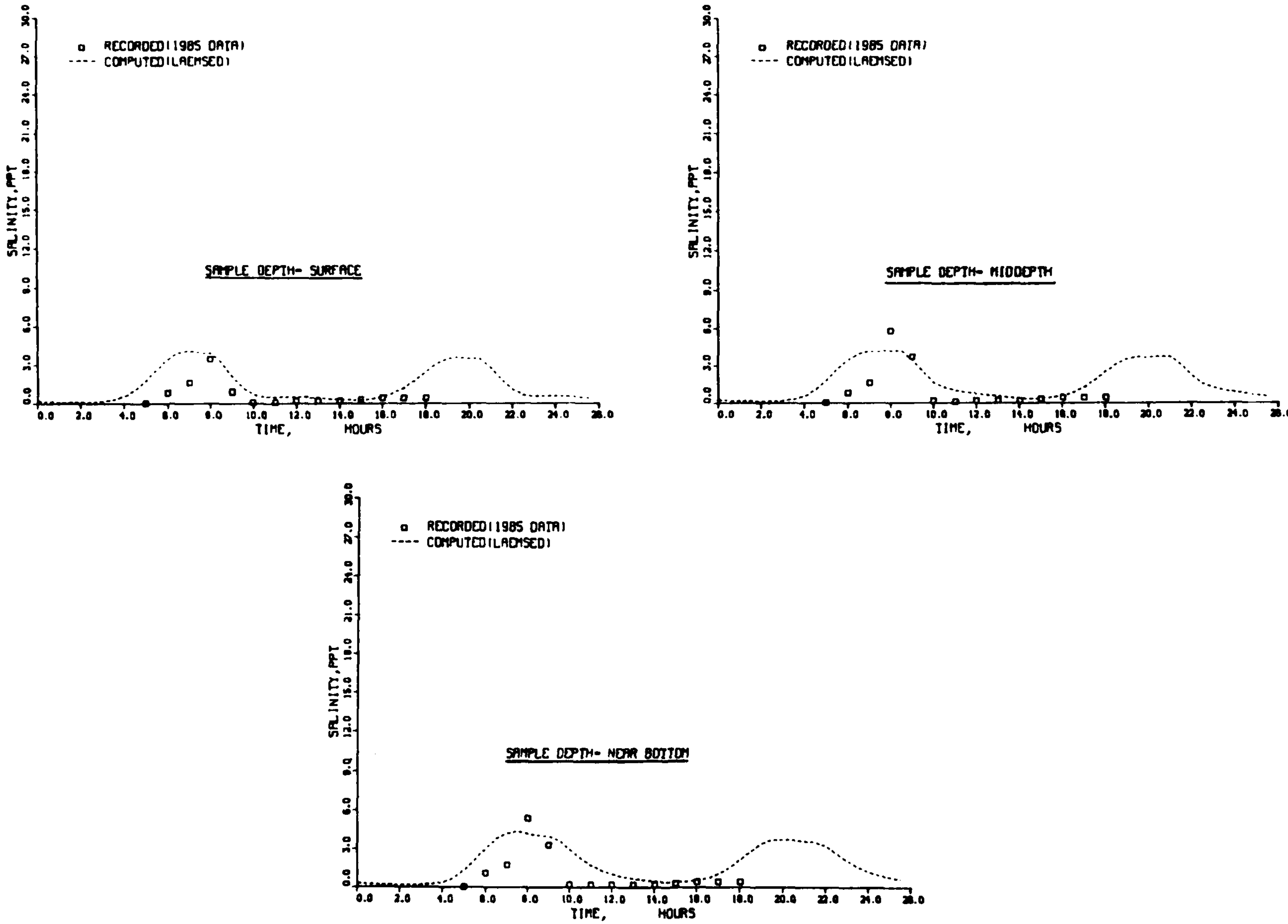


Figure 35. Comparison of computed and recorded salinity at Range 11

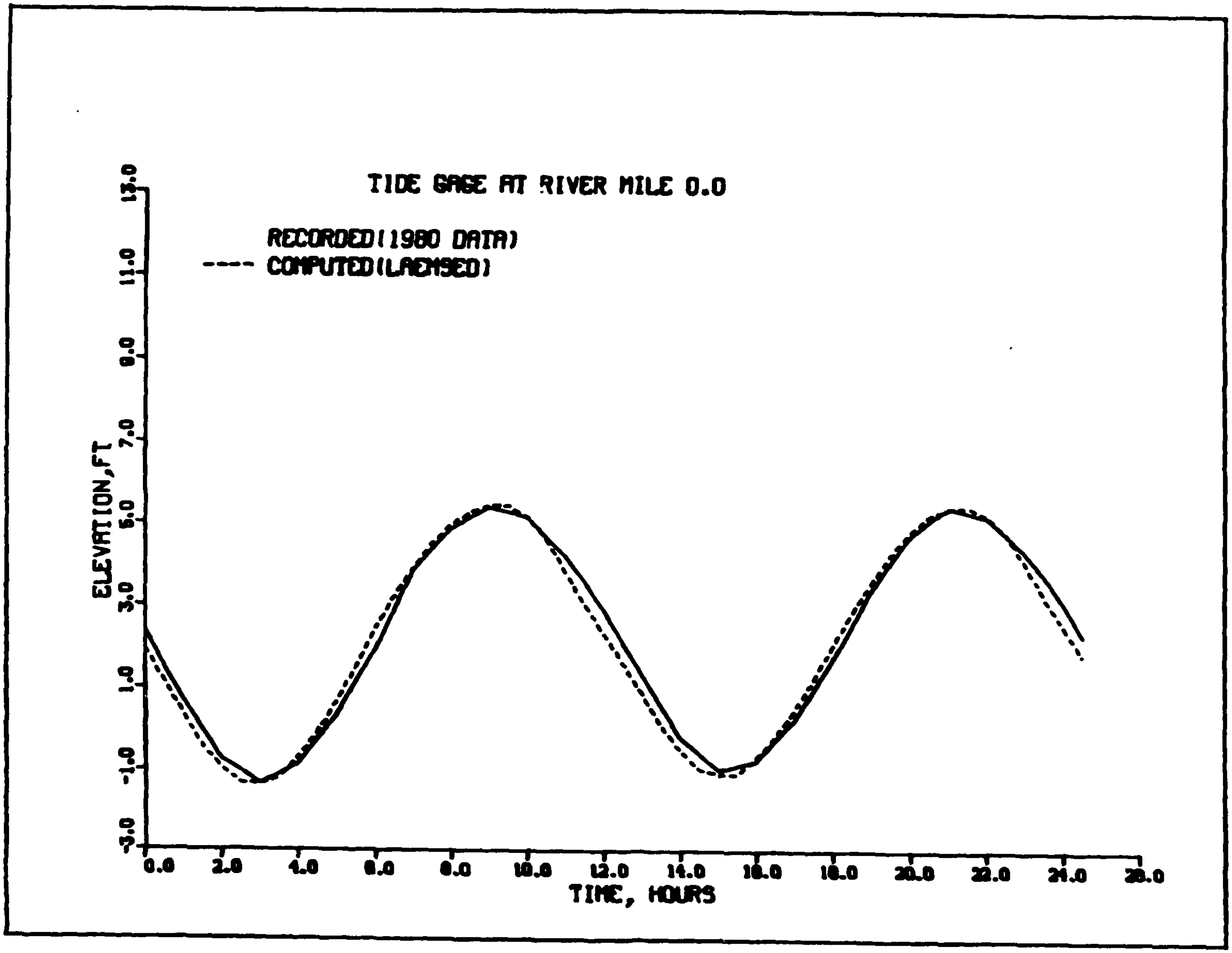


Figure 36. Comparison of computed and recorded tide at Fort Pulaski

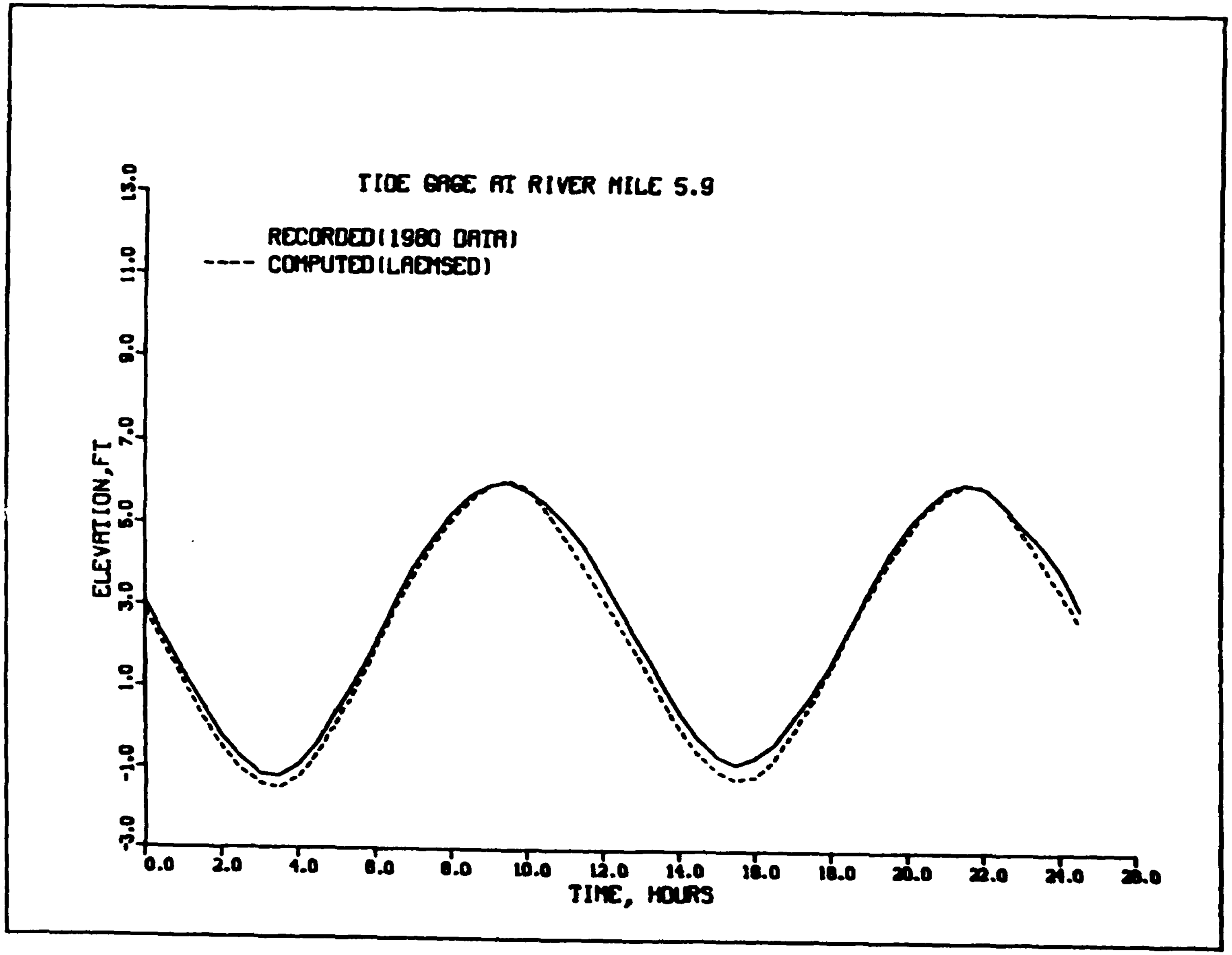


Figure 37. Comparison of computed and recorded tide at mile 5.9

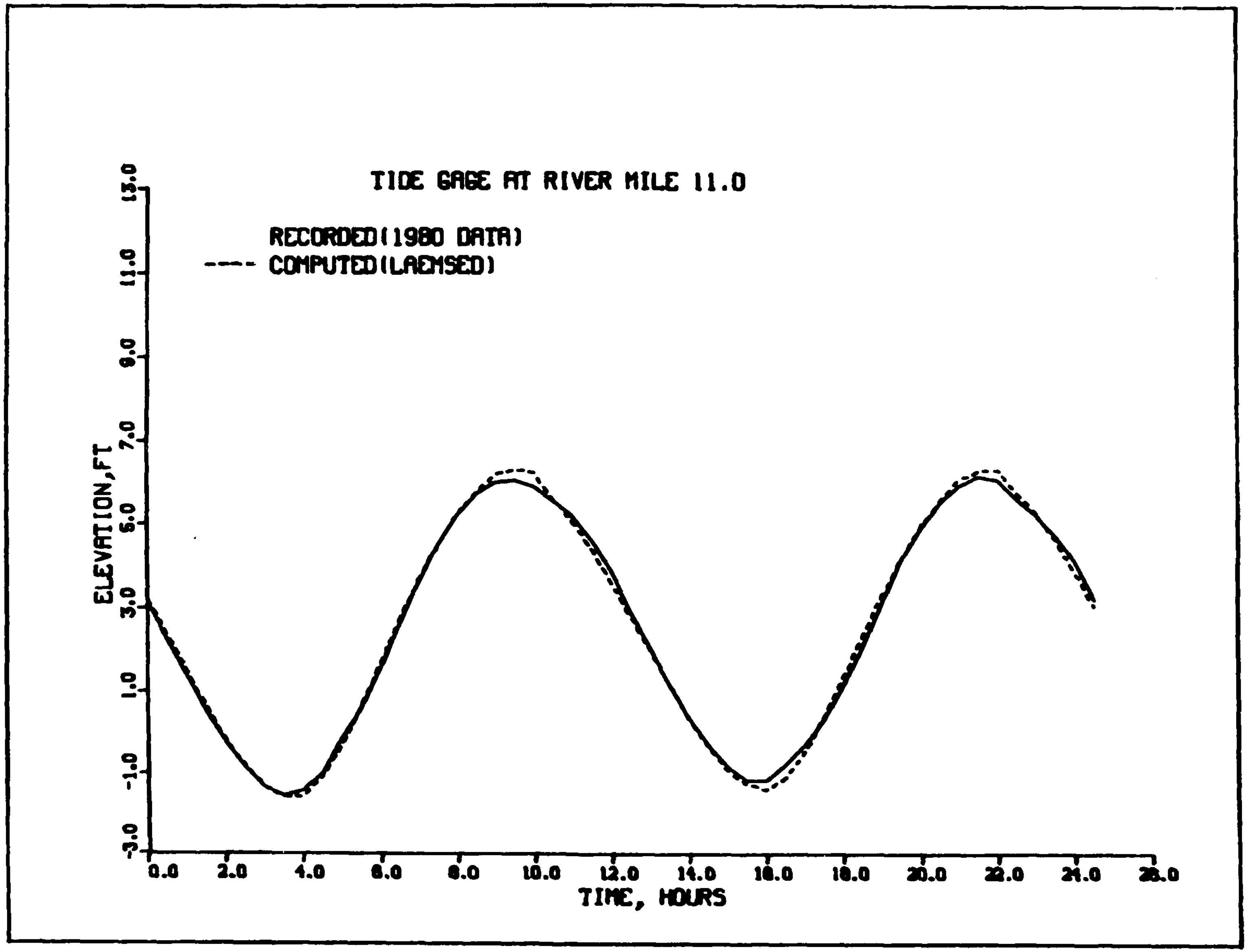


Figure 38. Comparison of computed and recorded tide at Fort Jackson

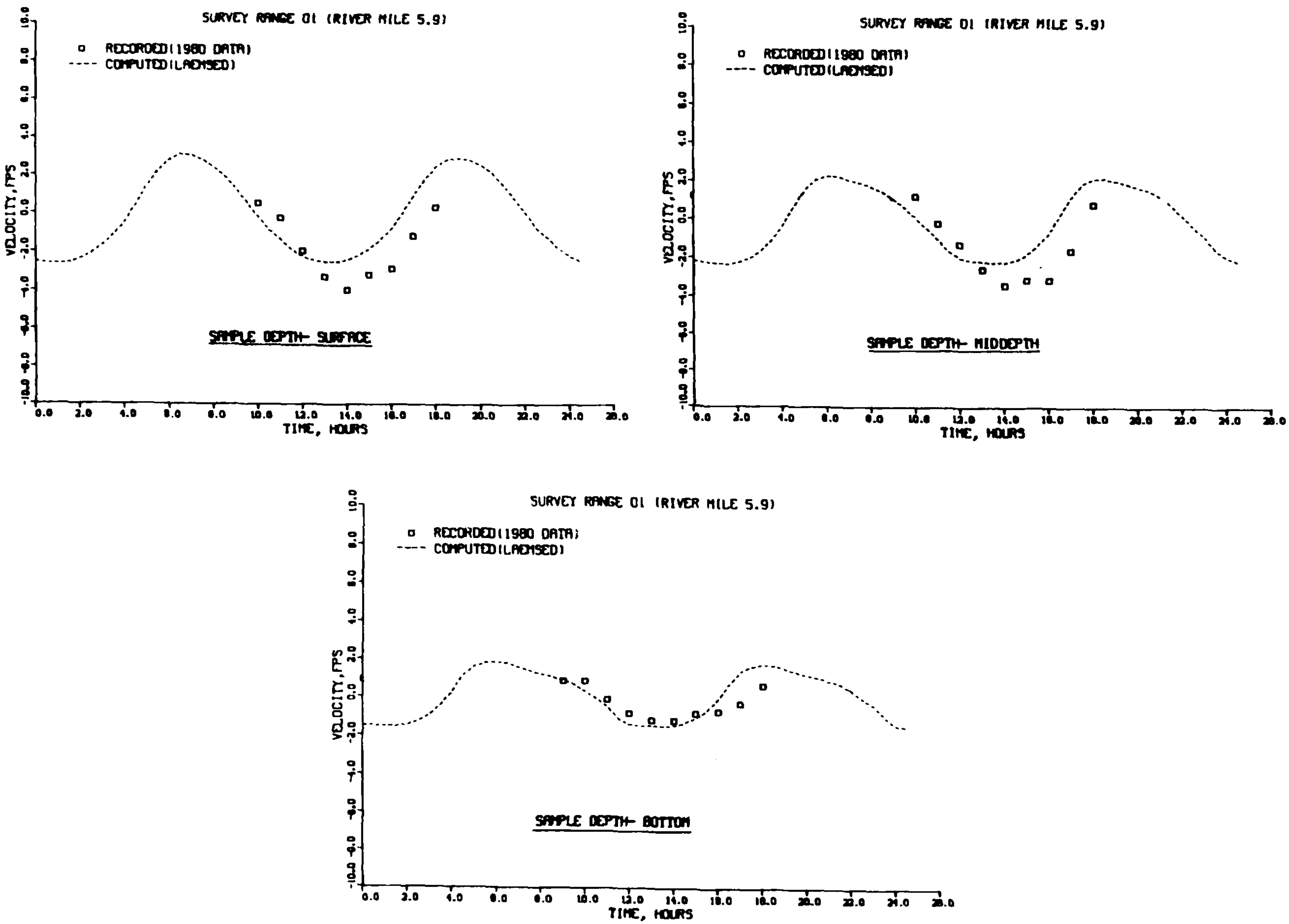


Figure 39. Comparison of computed and recorded velocity at mile 5.9

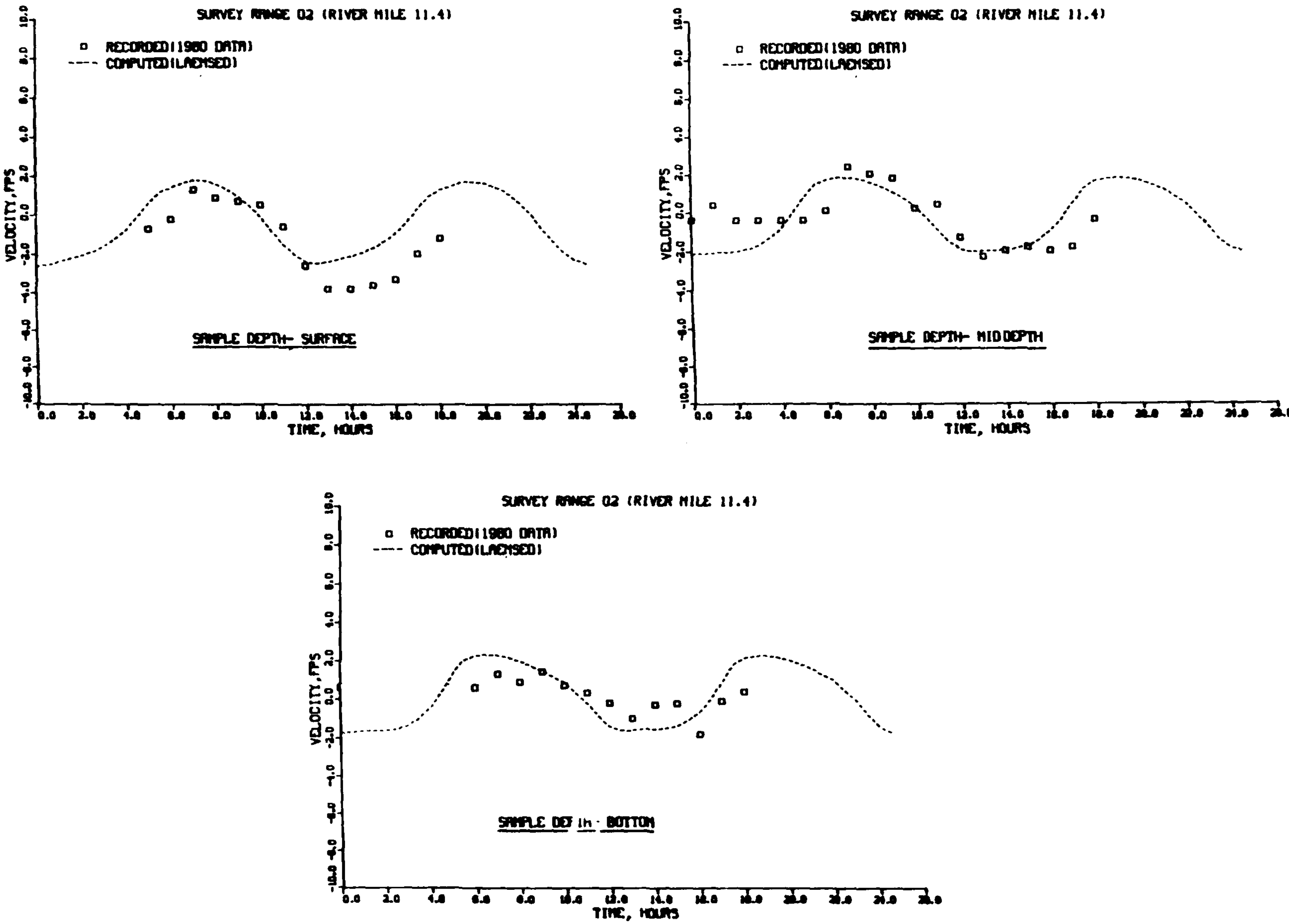


Figure 40. Comparison of computed and recorded velocity at mile 11.4

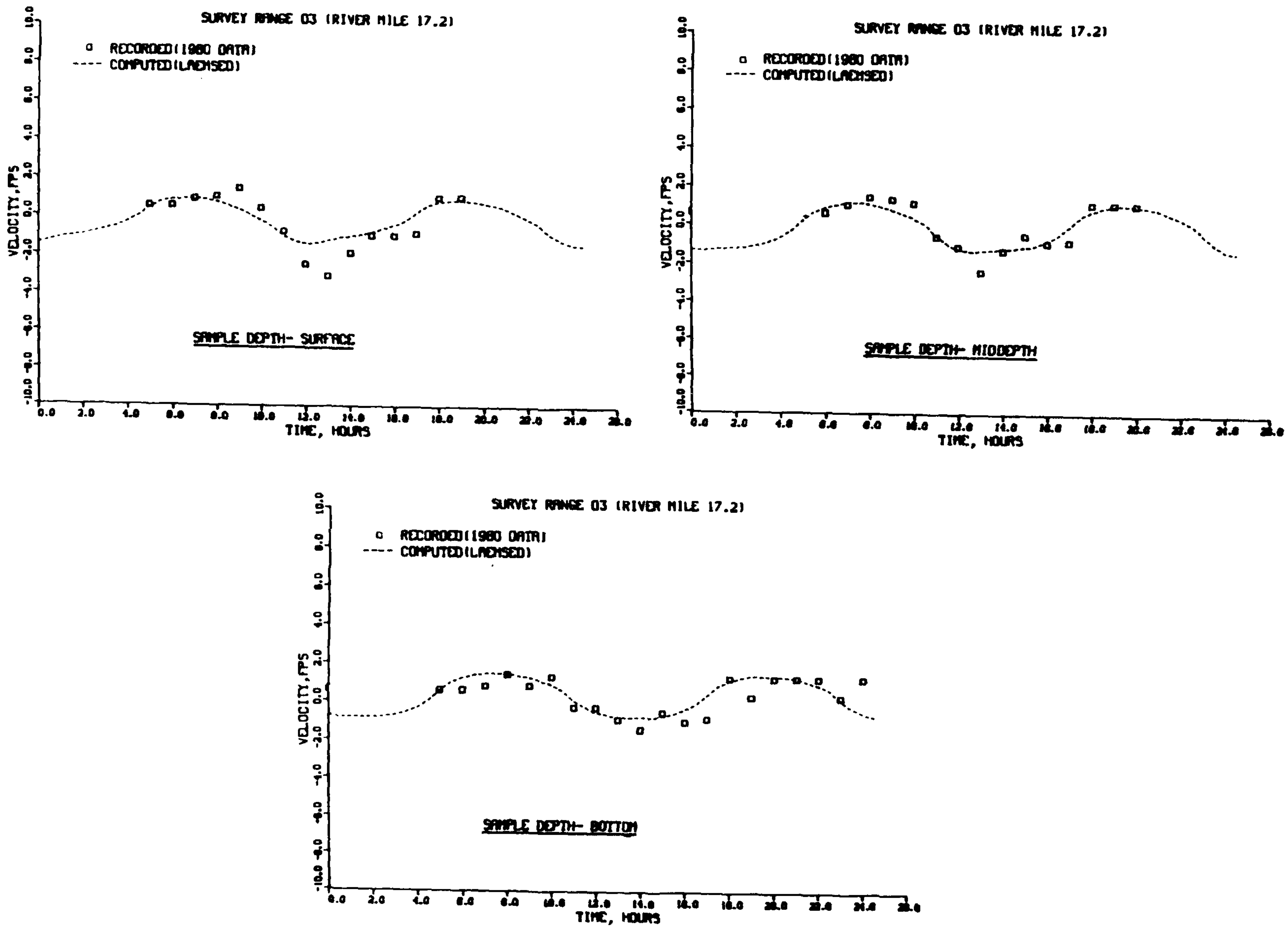


Figure 41. Comparison of computed and recorded velocity at mile 17.2

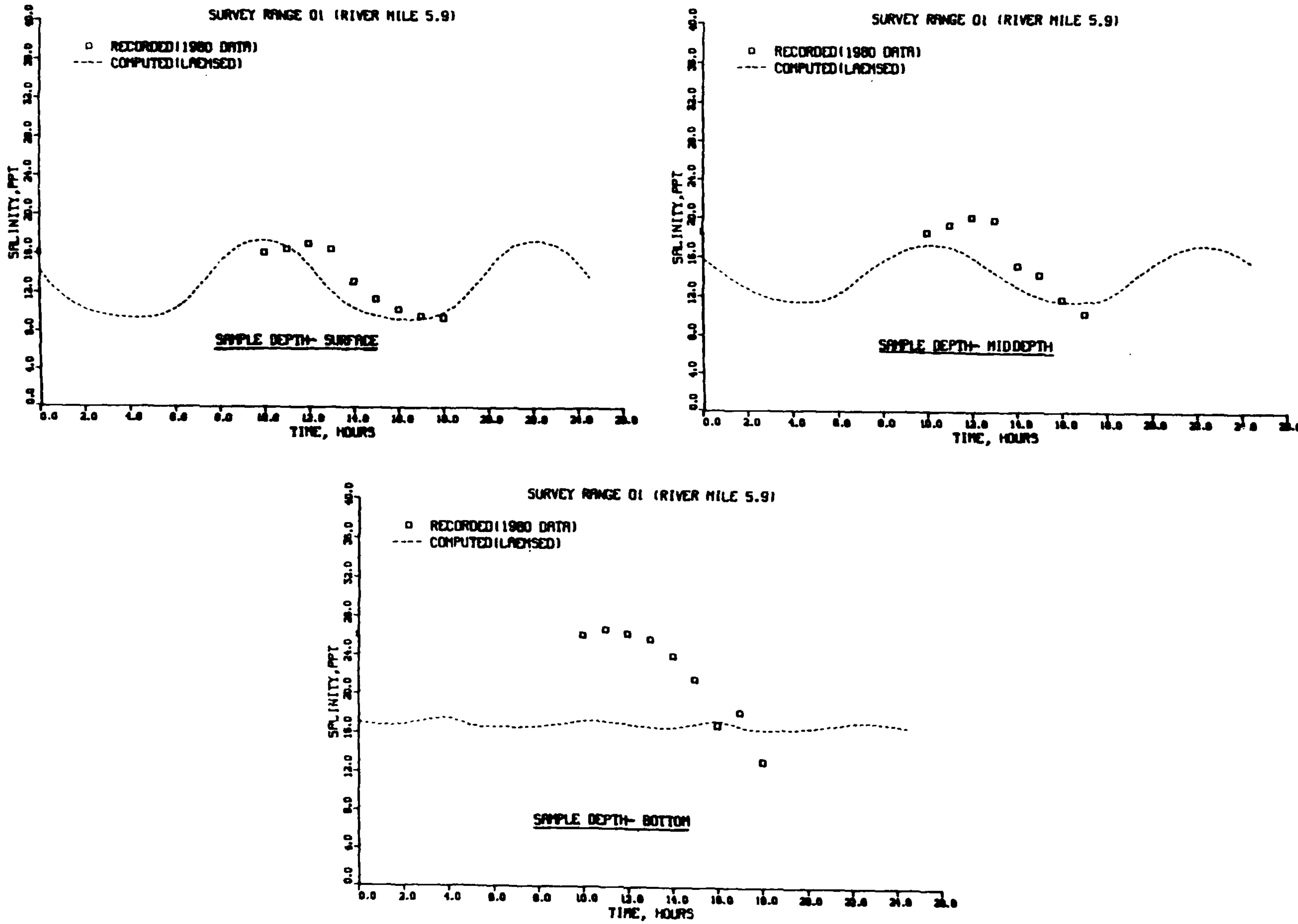


Figure 42. Comparison of computed and recorded salinity at mile 5.9

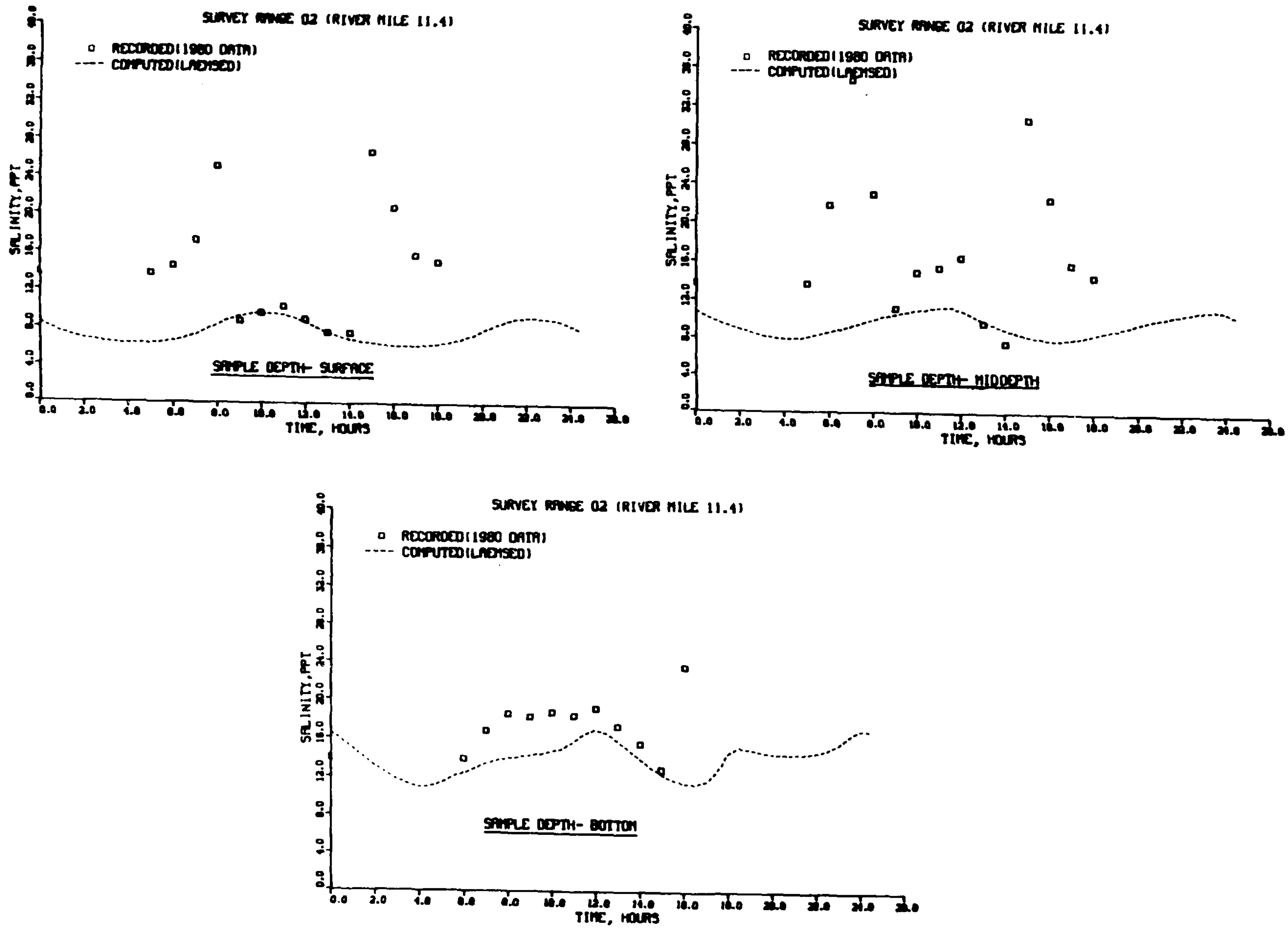


Figure 43. Comparison of computed and recorded salinity at mile 11.4

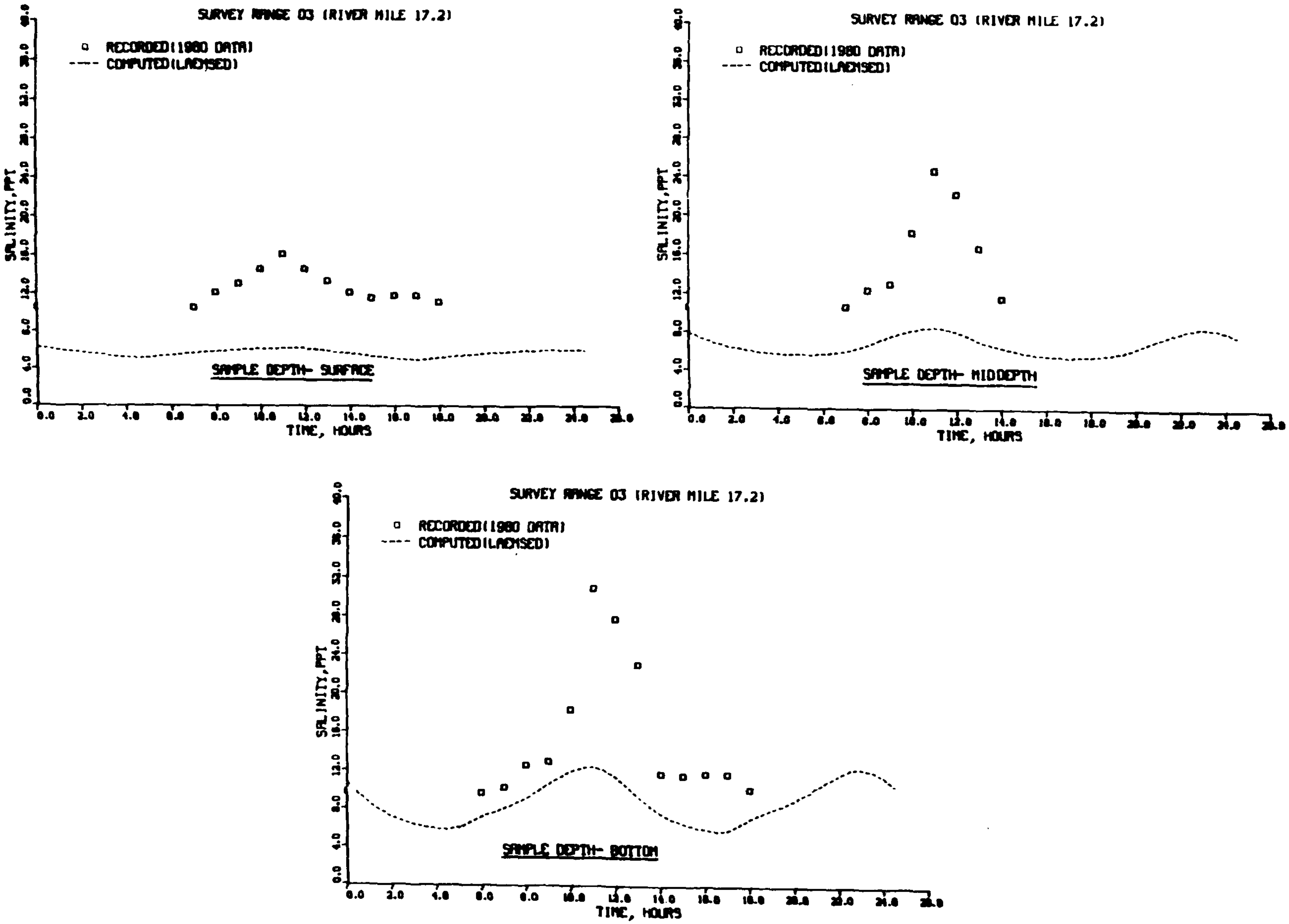


Figure 44. Comparison of computed and recorded salinity at mile 17.2

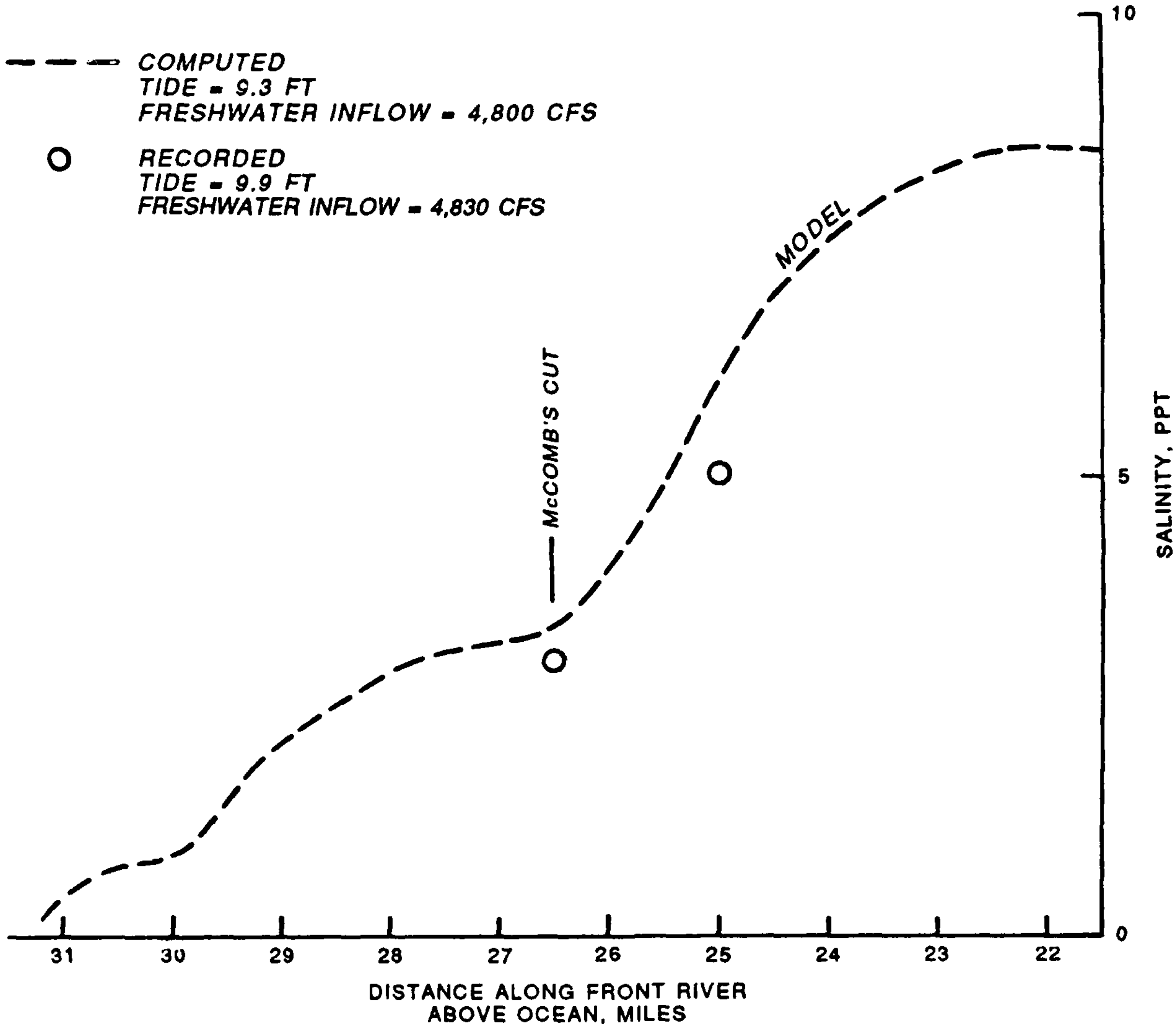


Figure 45. Salinity profile in upper estuary

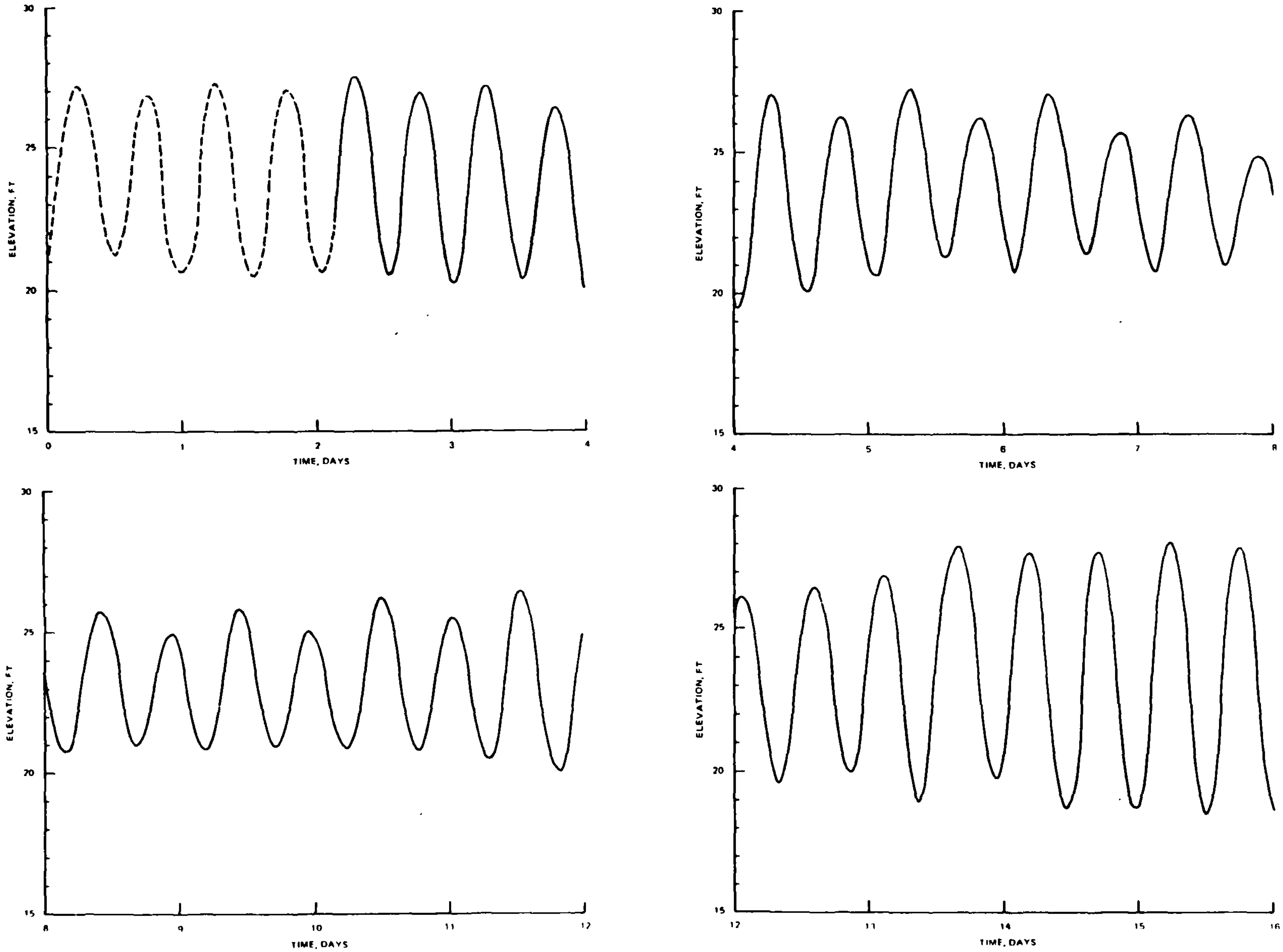


Figure 46. Recorded tide at Fort Pulaski, 28-day cycle. Dashed lines represent estimated record
(Continued)

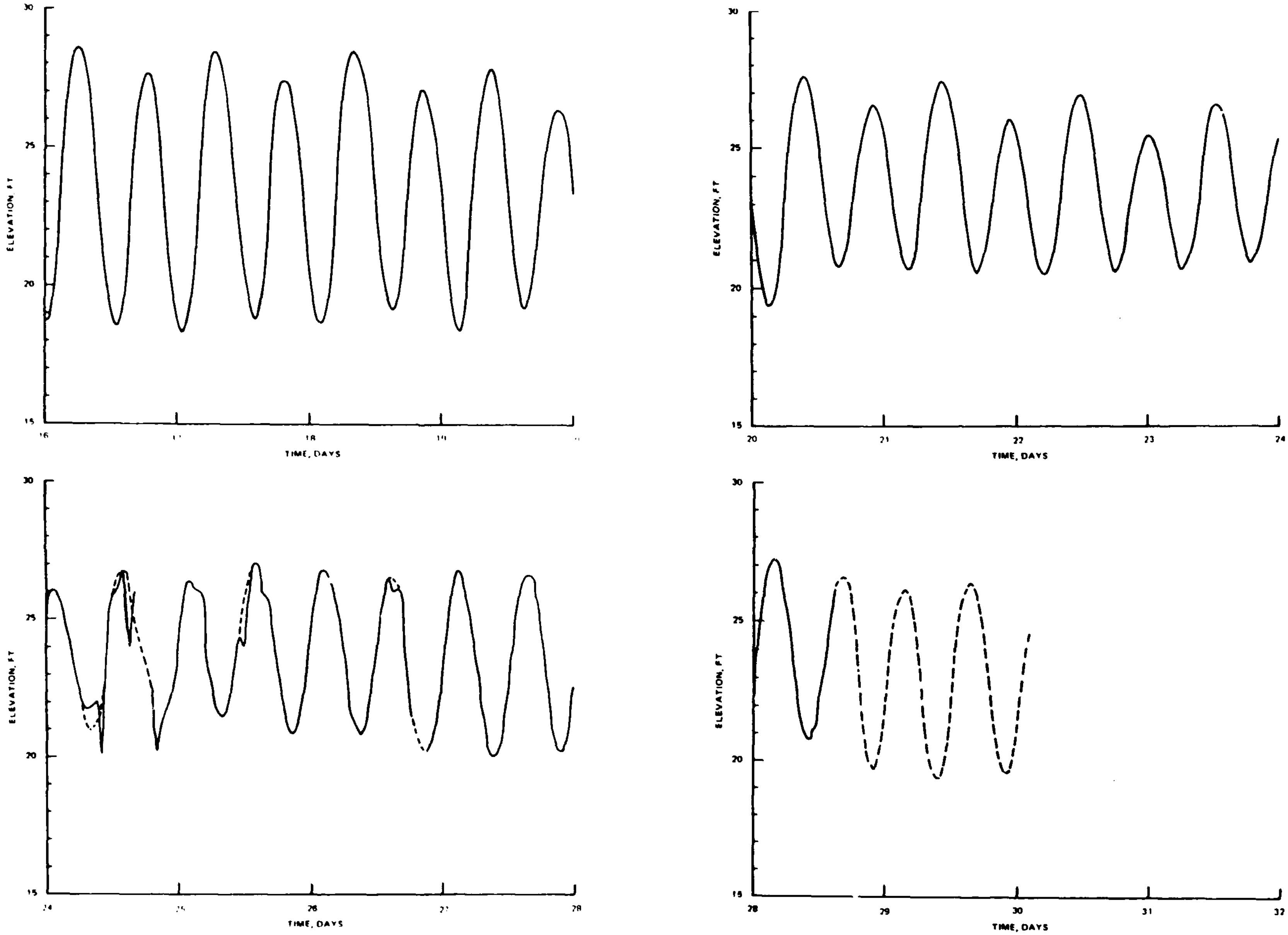


Figure 46. (Concluded)

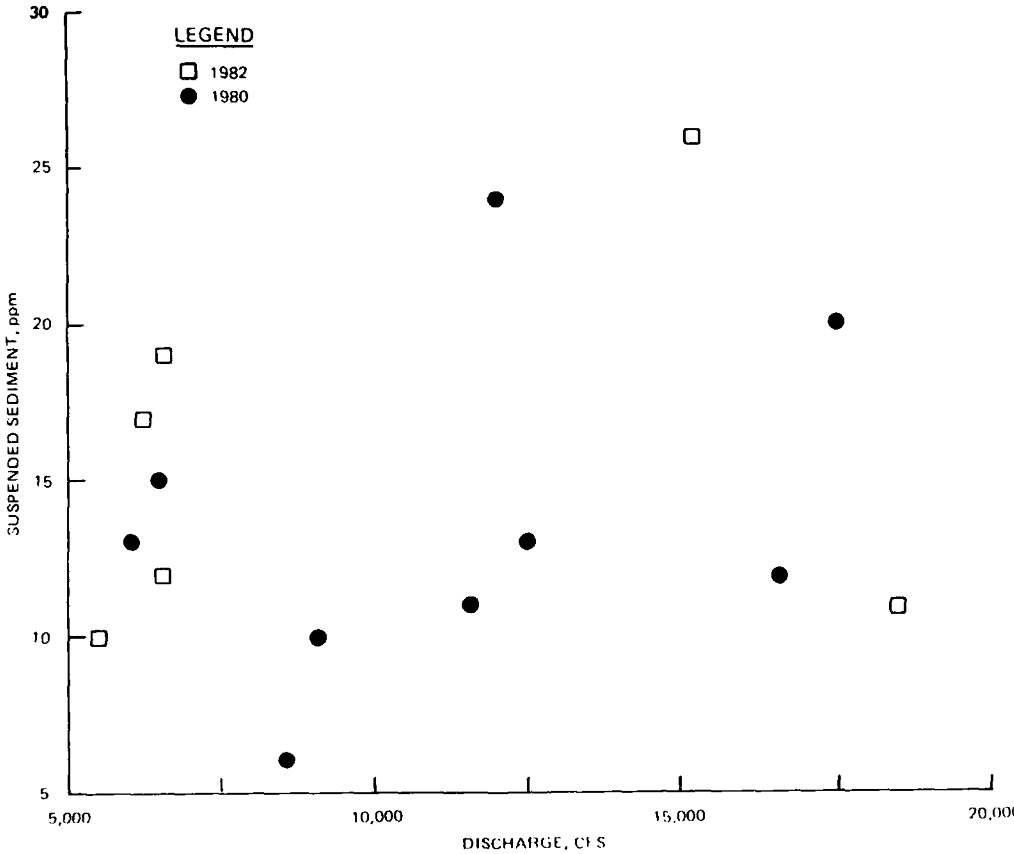


Figure 47. Suspended sediment concentrations near Clyo, Georgia

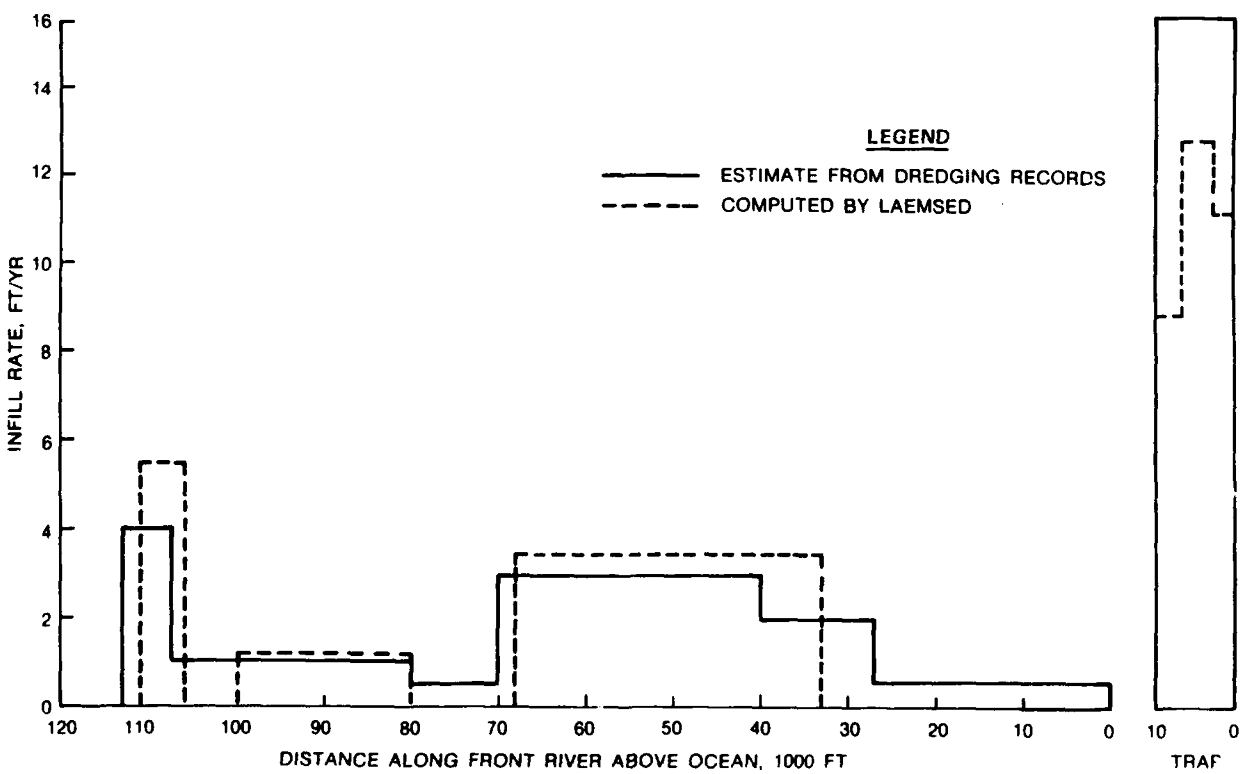


Figure 48. Comparison of computed and recorded shoaling

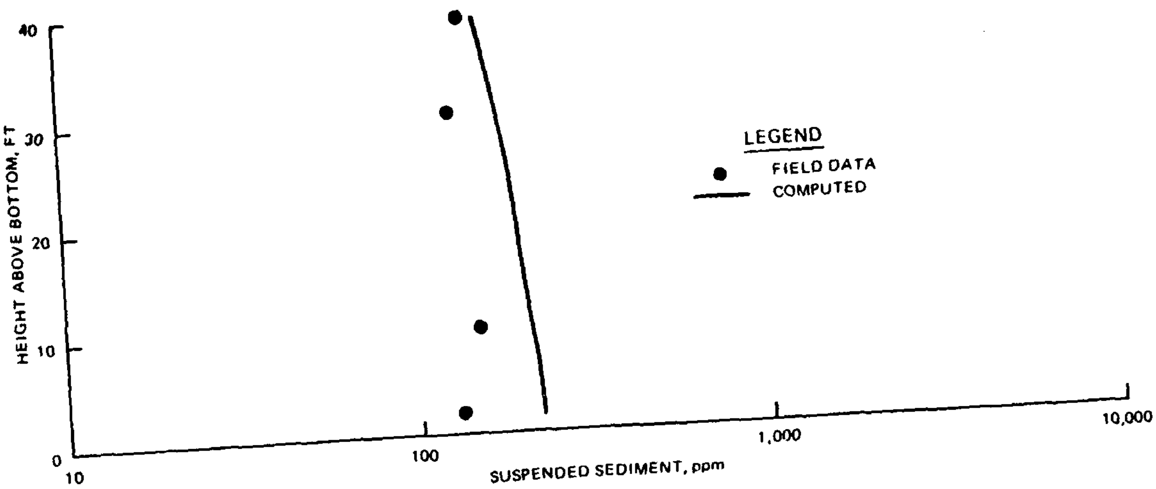


Figure 49. Suspended sediment concentrations at Range 1

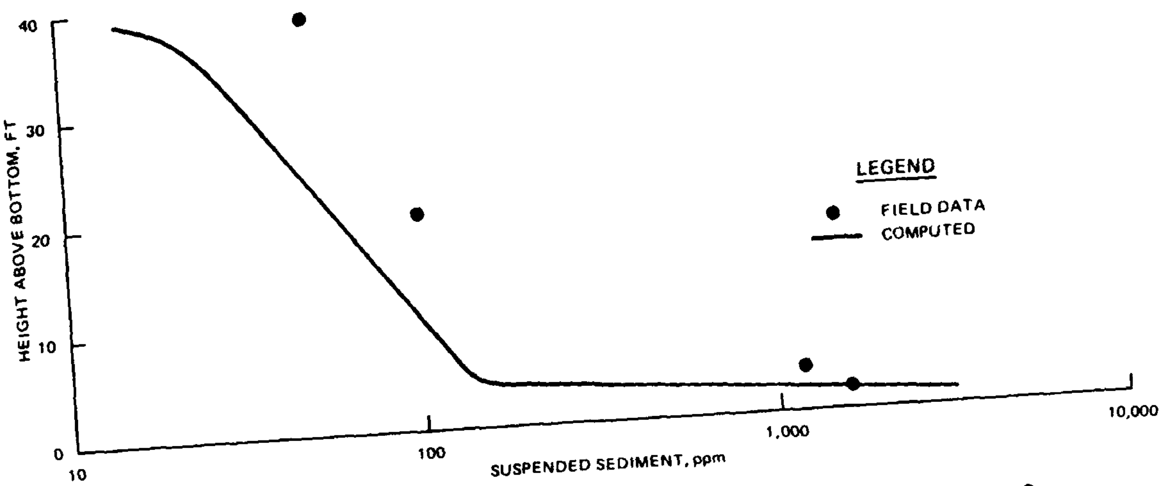


Figure 50. Suspended sediment concentrations at Range 2

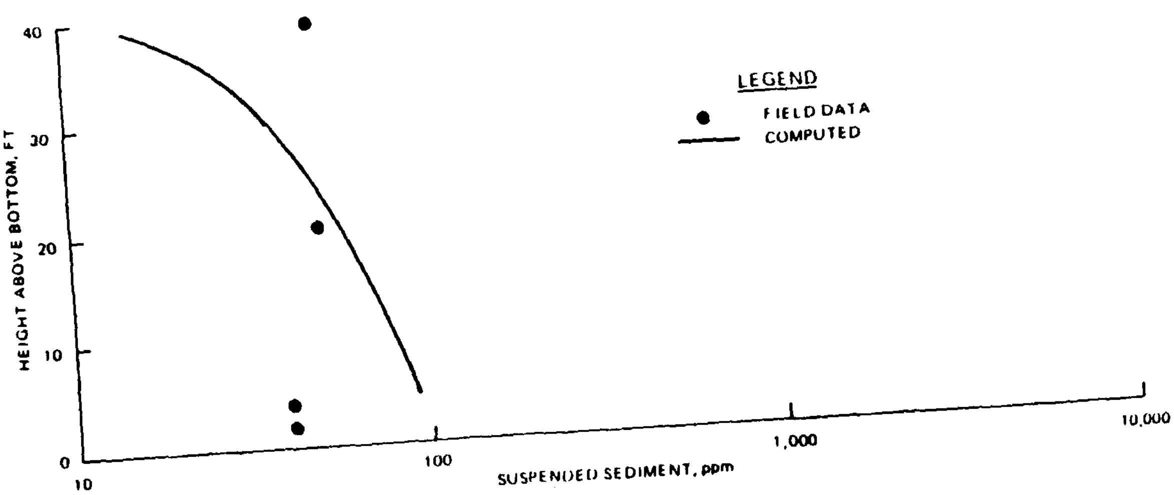


Figure 51. Suspended sediment concentrations in sediment trap

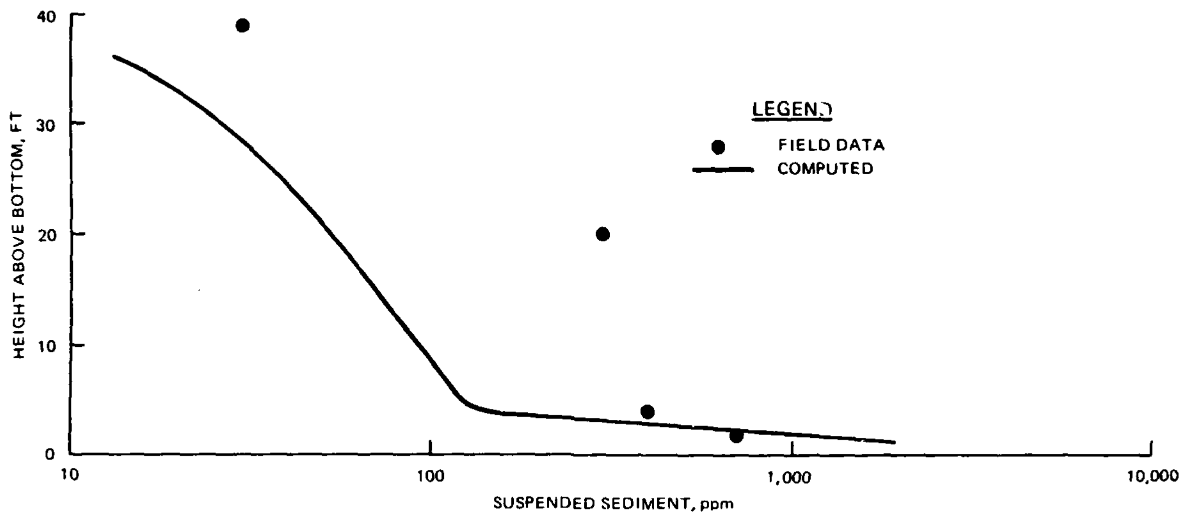


Figure 52. Suspended sediment concentrations at Range 5

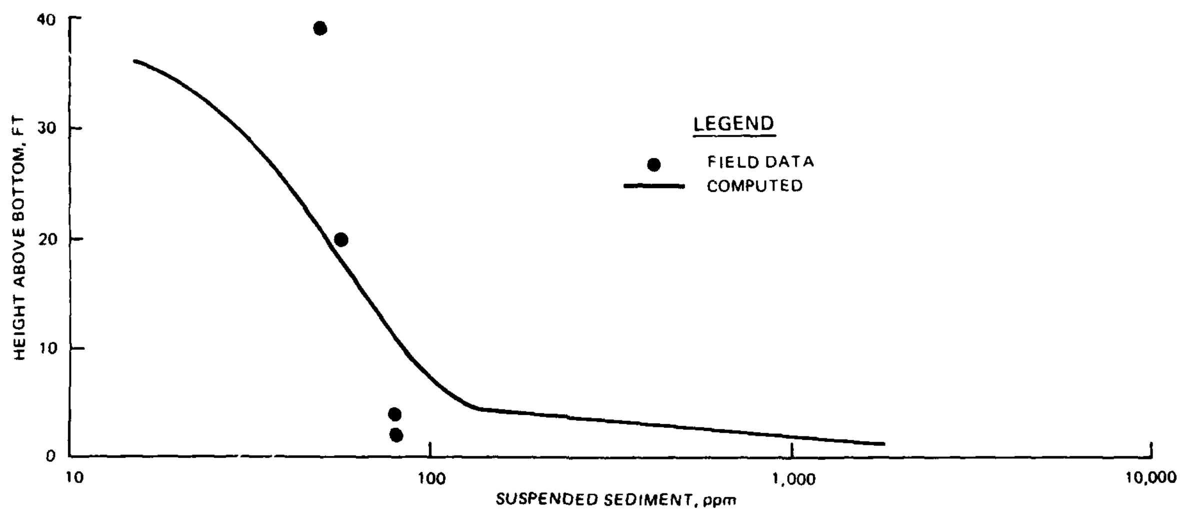


Figure 53. Suspended sediment concentrations at Range 6

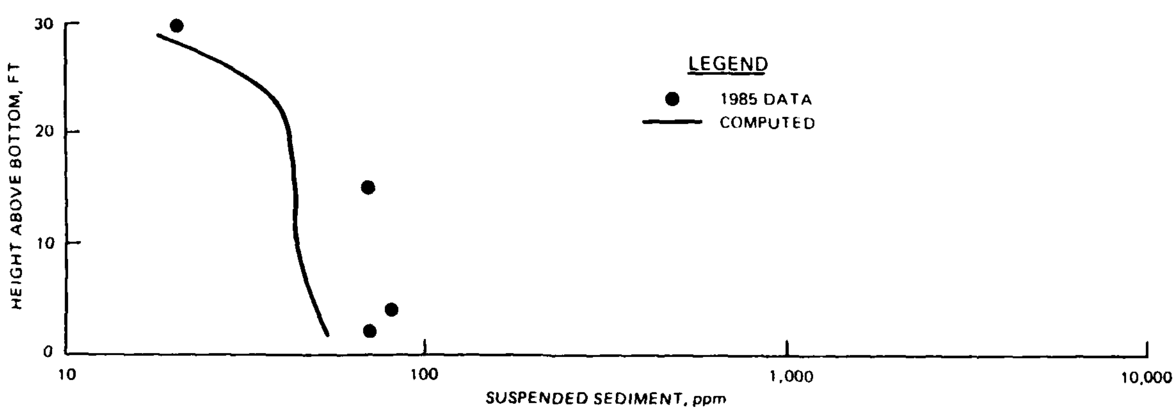


Figure 54. Suspended sediment concentrations at Range 7

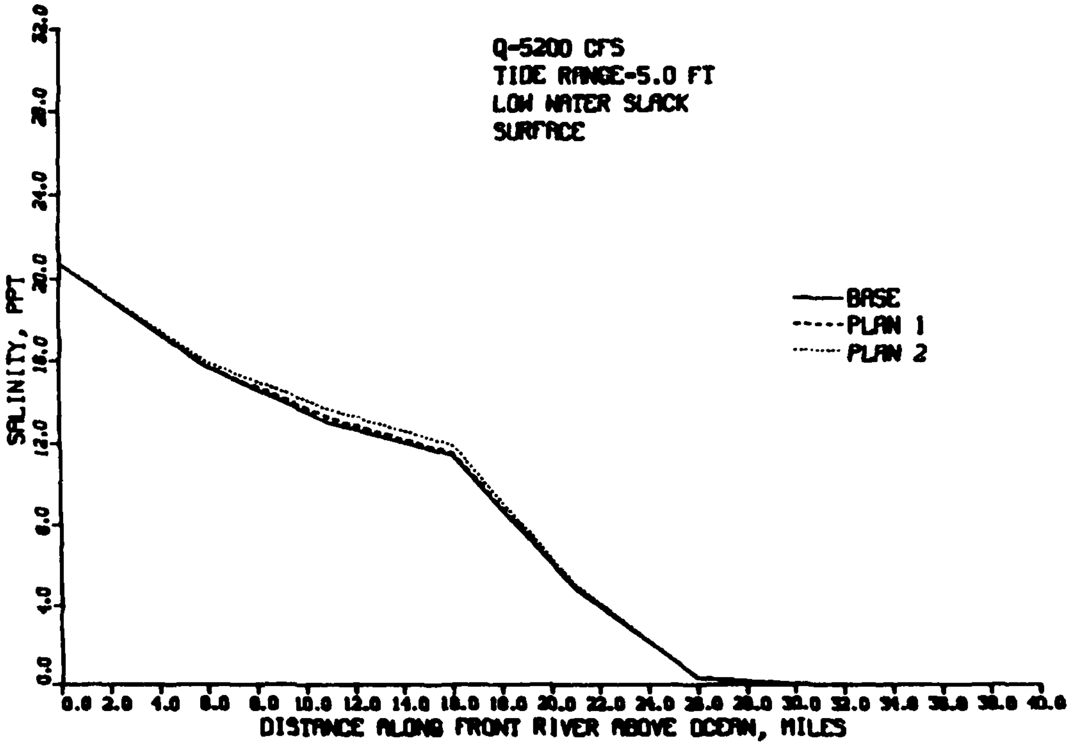


Figure 55. Salinity profile along Front River, 5,200-cfs discharge, 5-ft tide range, low-water slack, surface

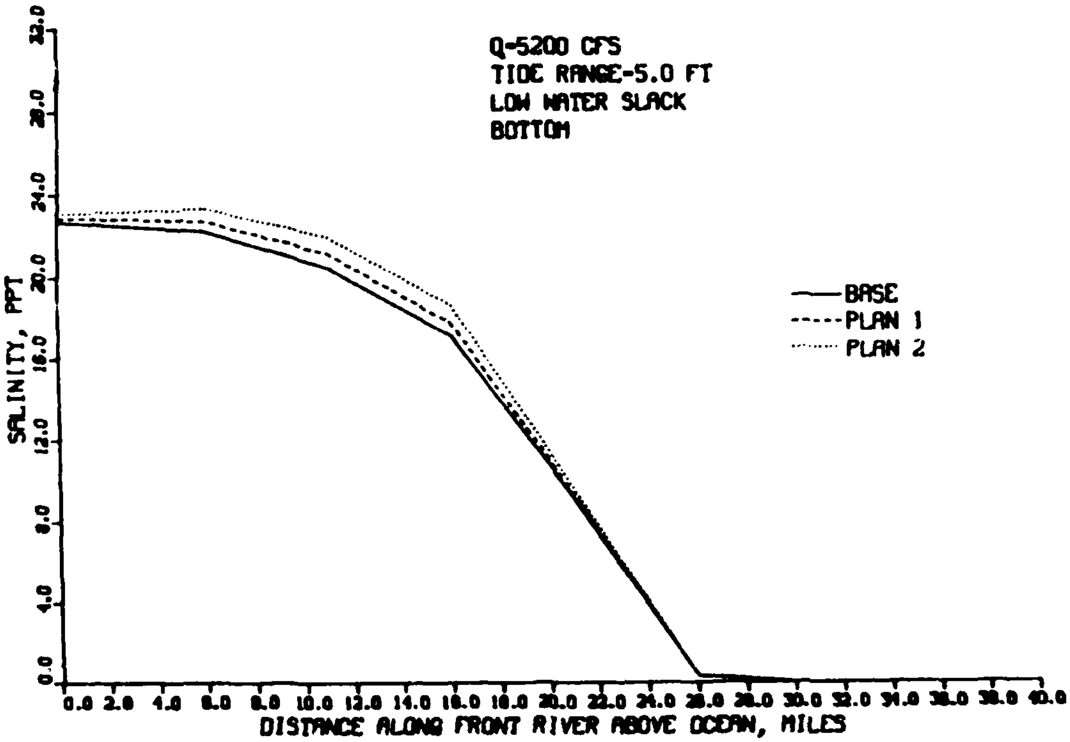


Figure 56. Salinity profile along Front River, 5,200-cfs discharge, 5-ft tide range, low-water slack, bottom

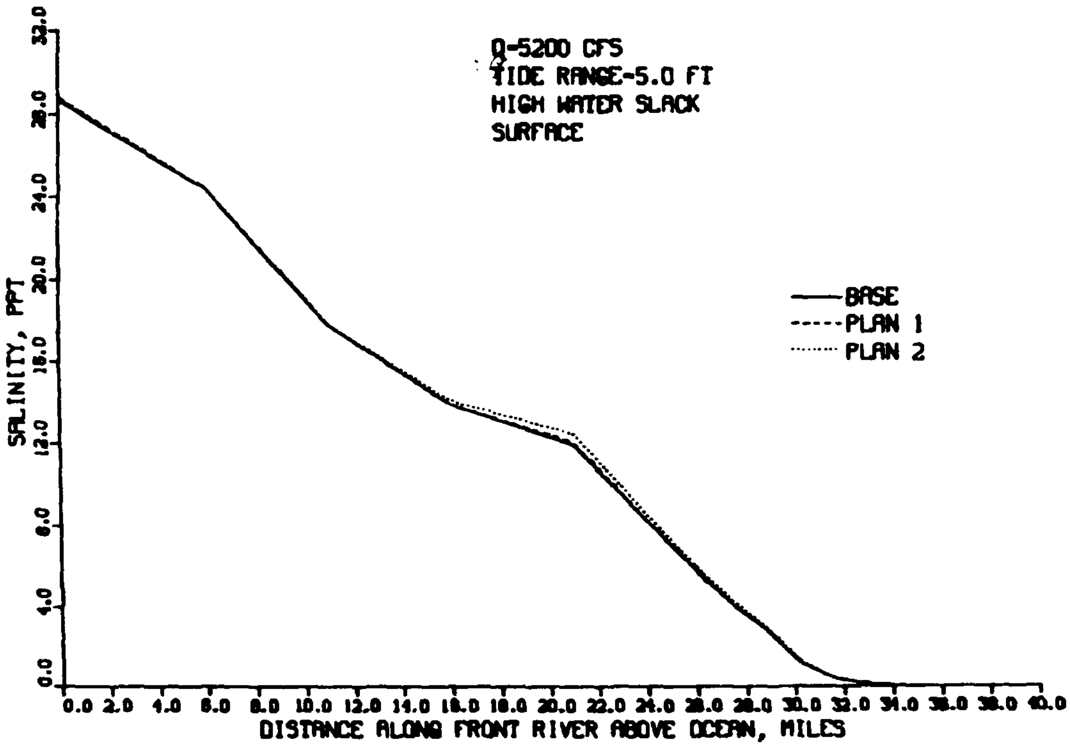


Figure 57. Salinity profile along Front River, 5,200-cfs discharge, 5-ft tide range, high-water slack, surface

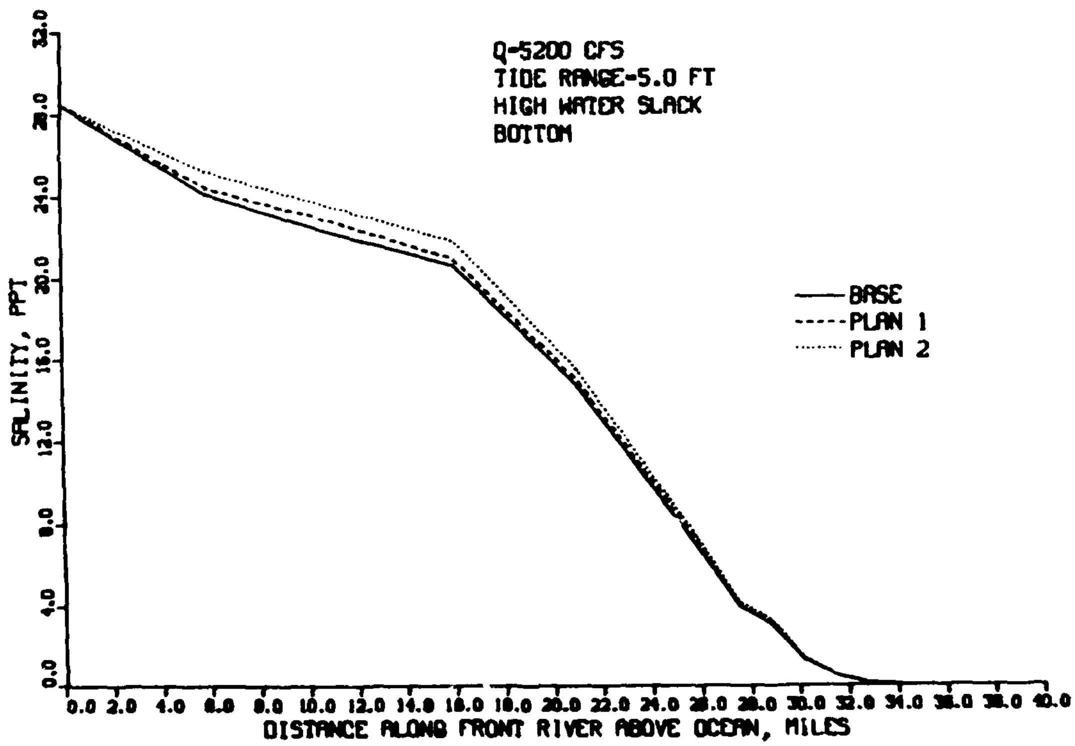


Figure 58. Salinity profile along Front River, 5,200-cfs discharge, 5-ft tide range, high-water slack, bottom

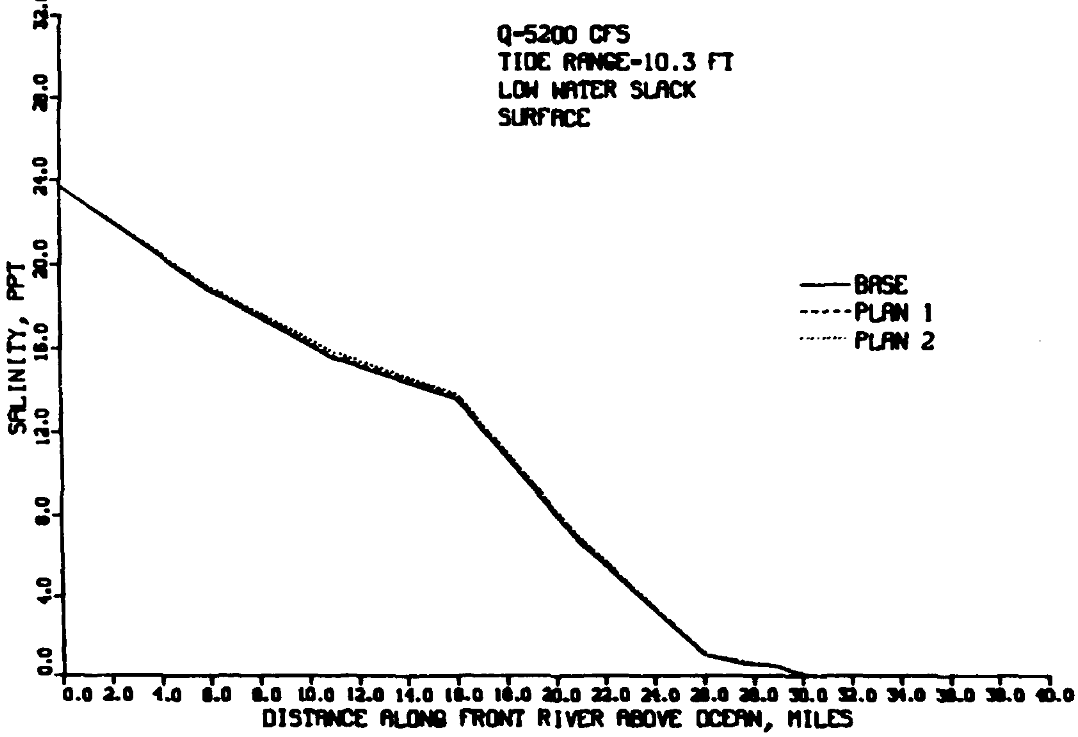


Figure 59. Salinity profile along Front River, 5,200-cfs discharge, 10.3-ft tide range, low-water slack, surface

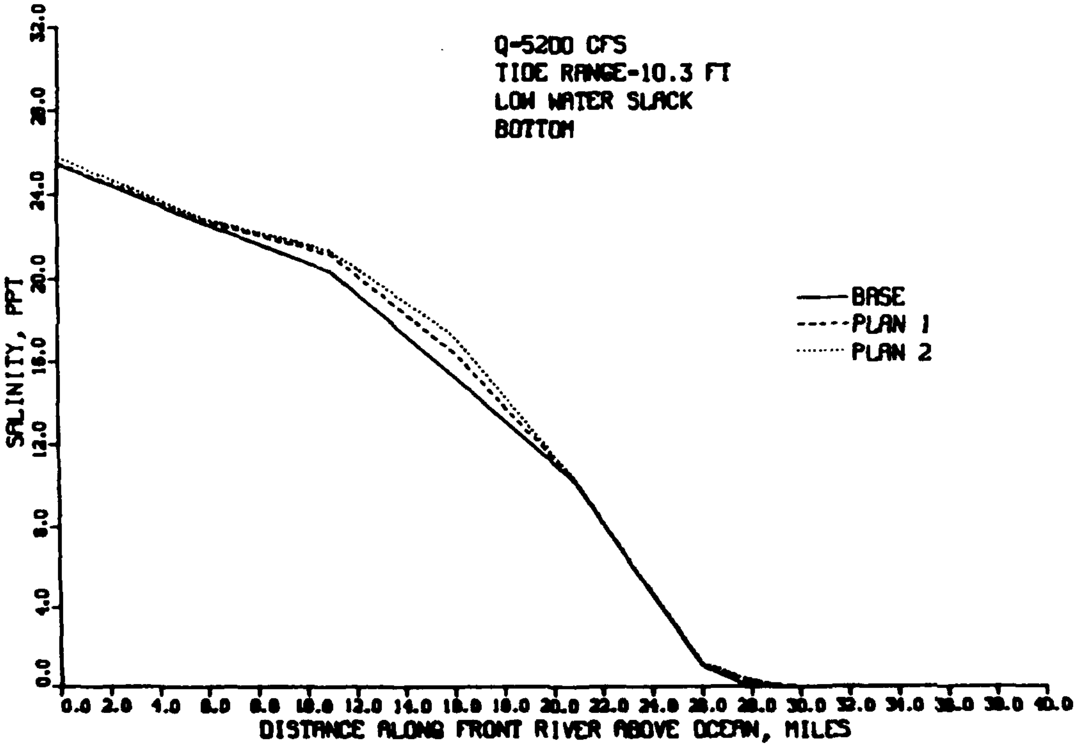


Figure 60. Salinity profile along Front River, 5,200-cfs discharge, 10.3-ft tide range, low-water slack, bottom

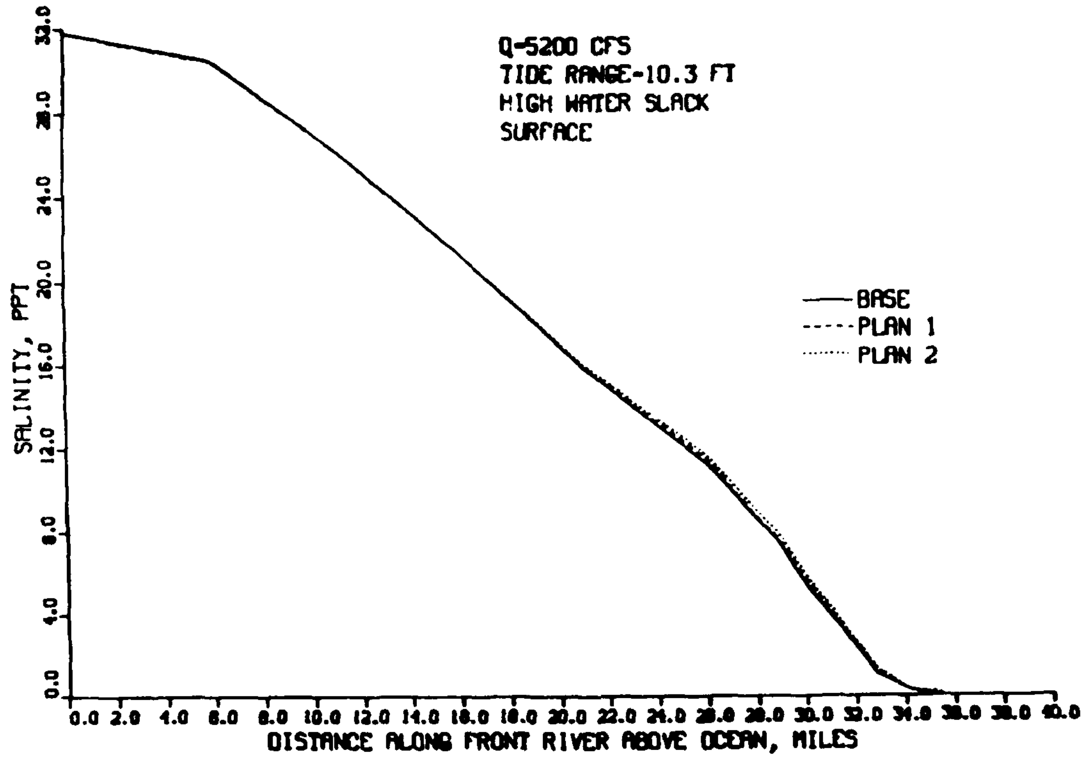


Figure 61. Salinity profile along Front River, 5,200-cfs discharge, 10.3-ft tide range, high-water slack, surface

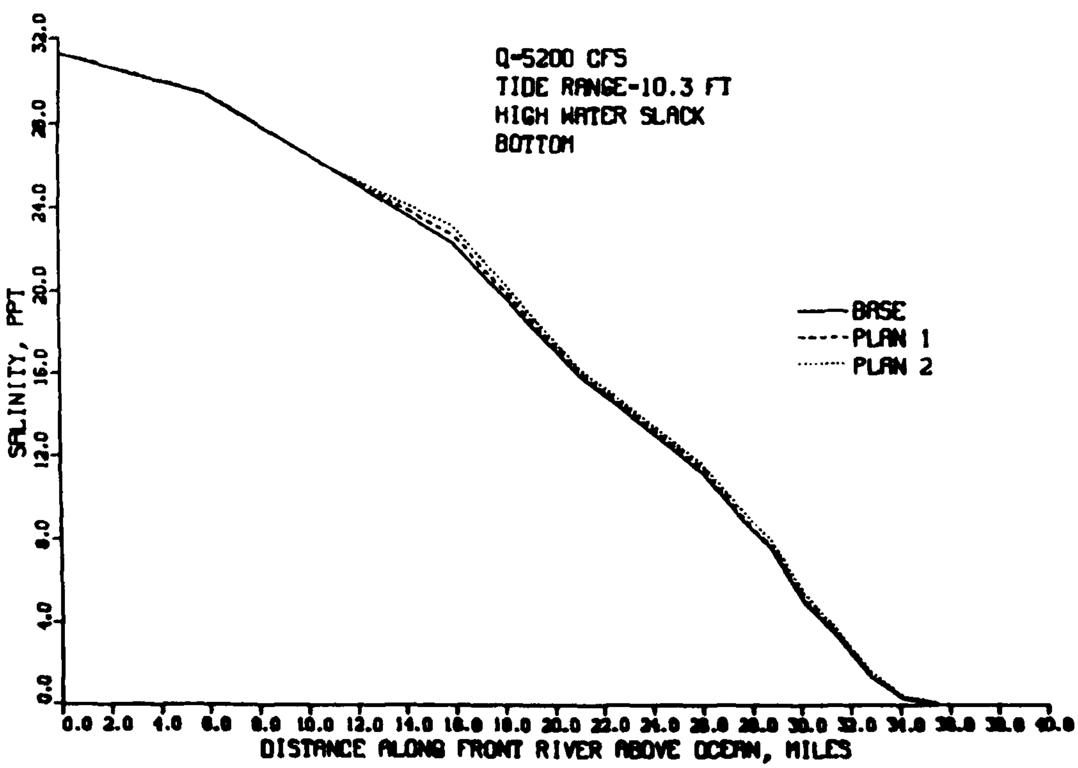


Figure 62. Salinity profile along Front River, 5,200-cfs discharge, 10.3-ft tide range, high-water slack, bottom

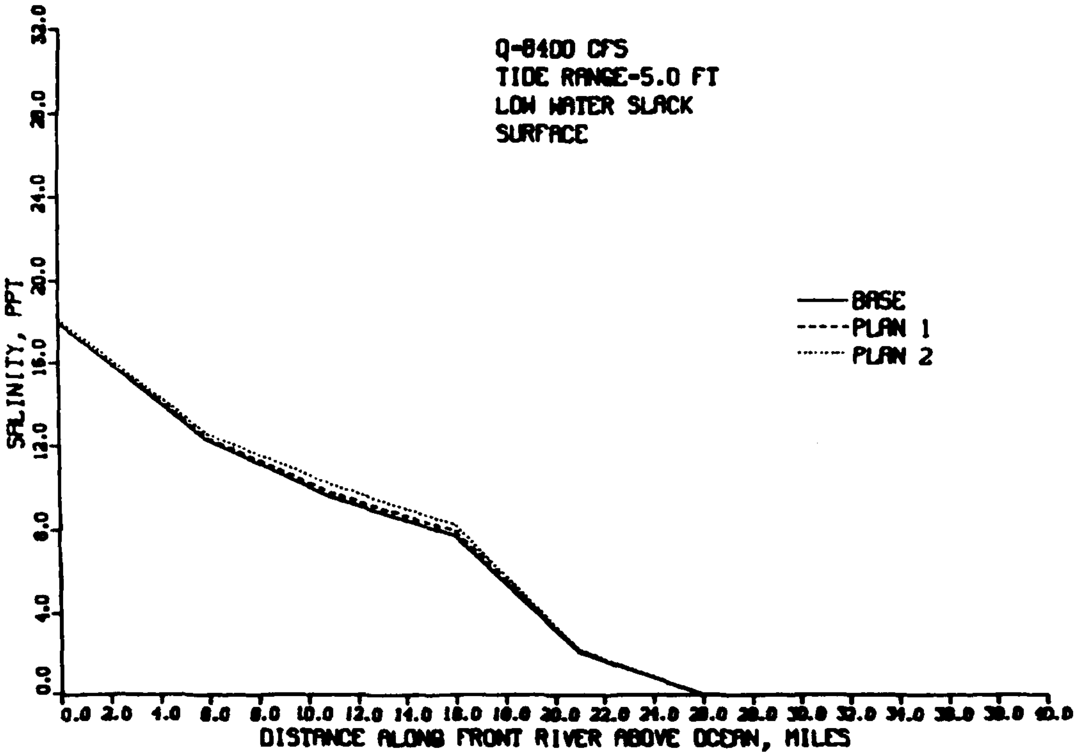


Figure 63. Salinity profile along Front River, 8,400-cfs discharge, 5-ft tide range, low-water slack, surface

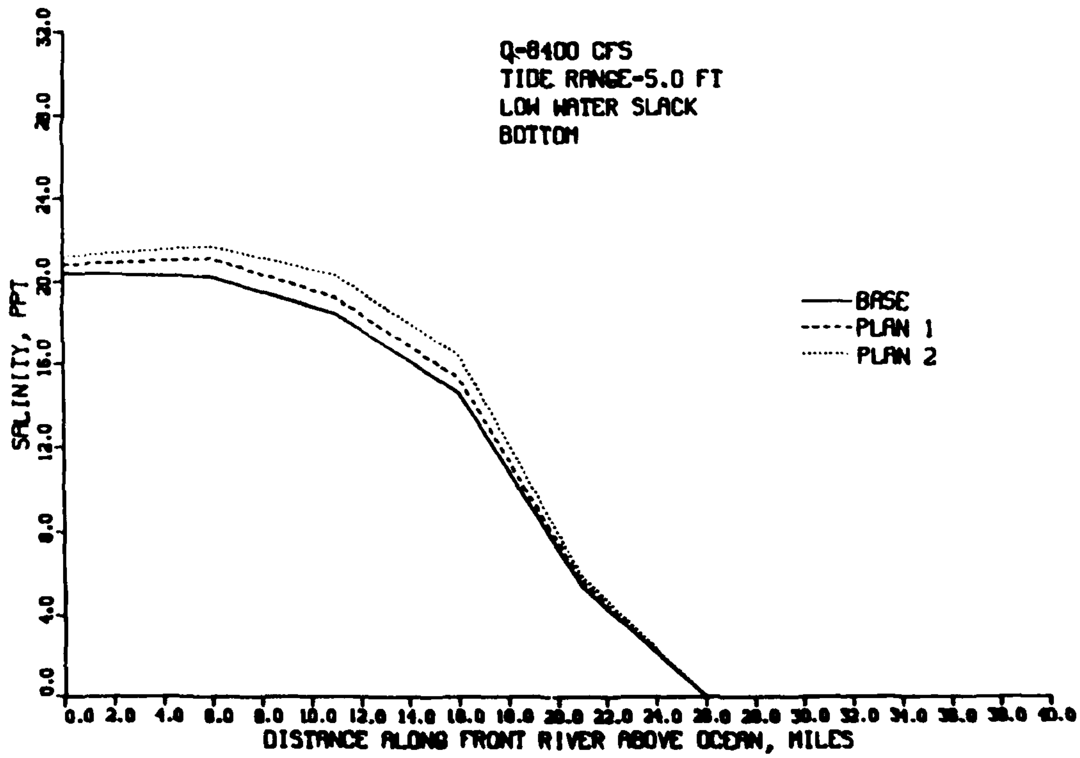


Figure 64. Salinity profile along Front River, 8,400-cfs discharge, 5-ft tide range, low-water slack, bottom

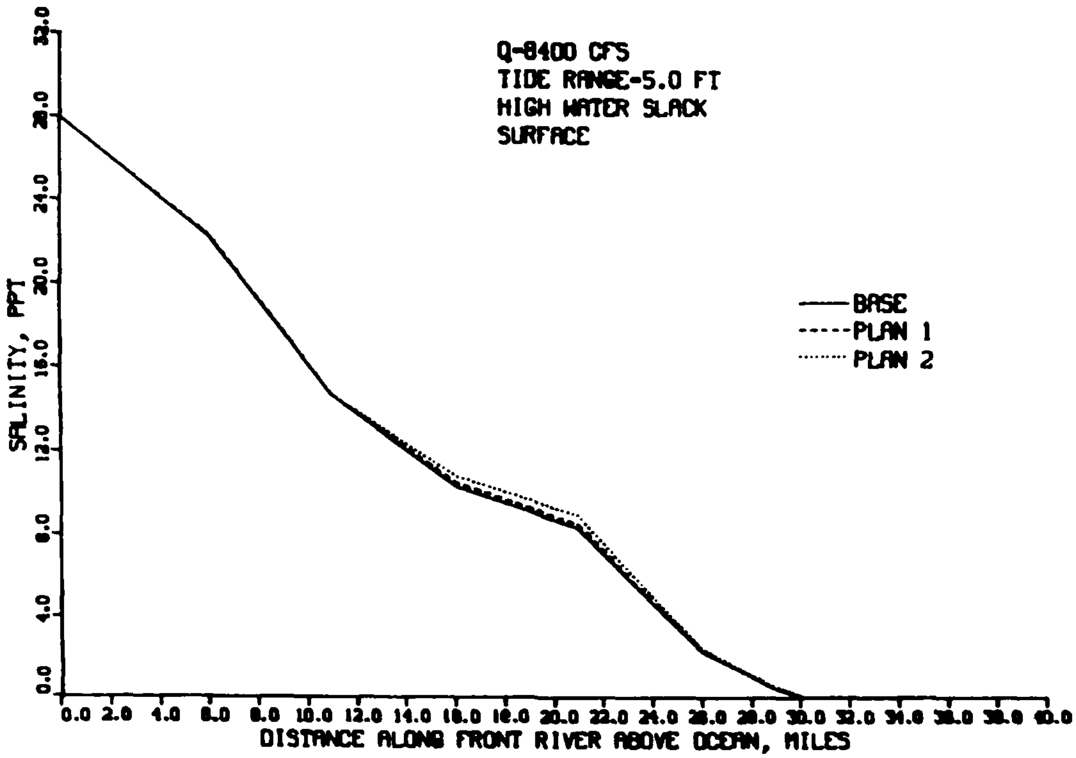


Figure 65. Salinity profile along Front River, 8,400-cfs discharge, 5-ft tide range, high-water slack, surface

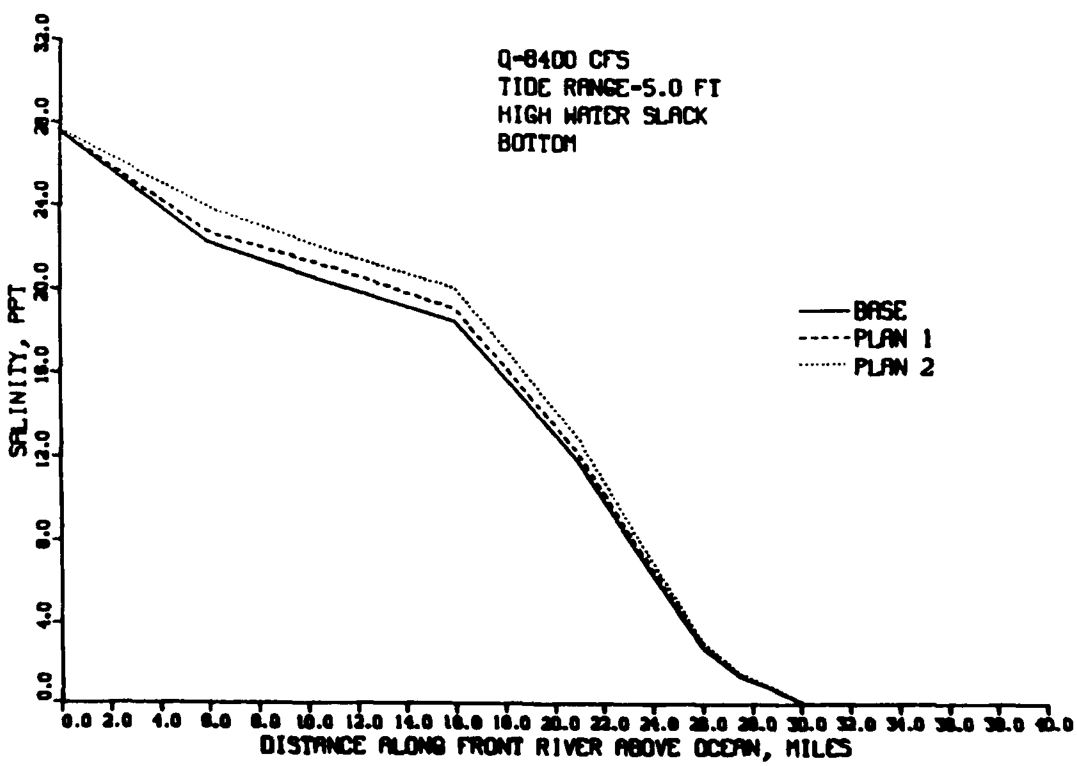


Figure 66. Salinity profile along Front River, 8,400-cfs discharge, 5-ft tide range, high-water slack, bottom

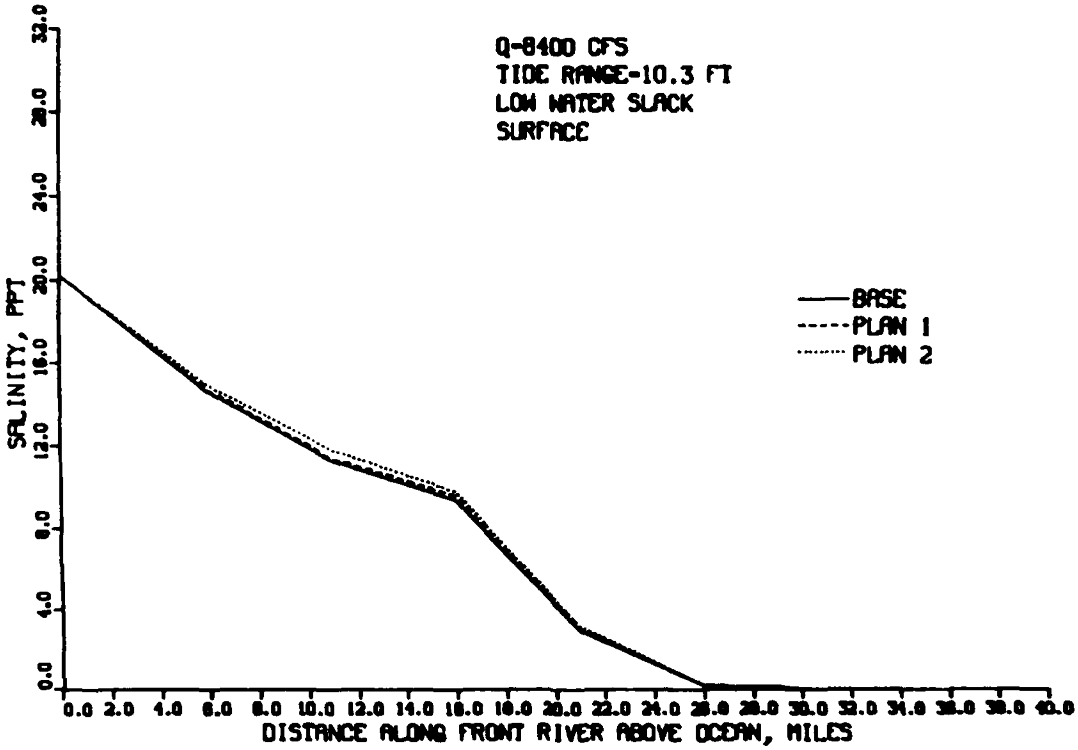


Figure 67. Salinity profile along Front River, 8,400-cfs discharge, 10.3-ft tide range, low-water slack, surface

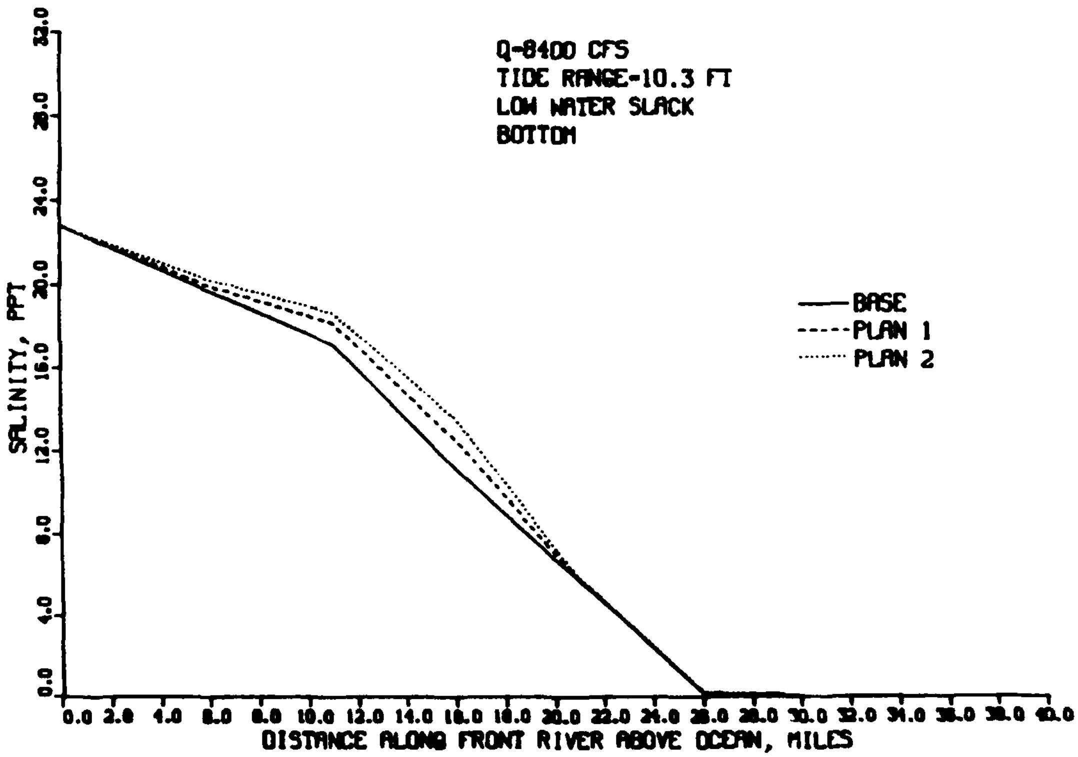


Figure 68. Salinity profile along Front River, 8,400-cfs discharge, 10.3-ft tide range, low-water slack, bottom

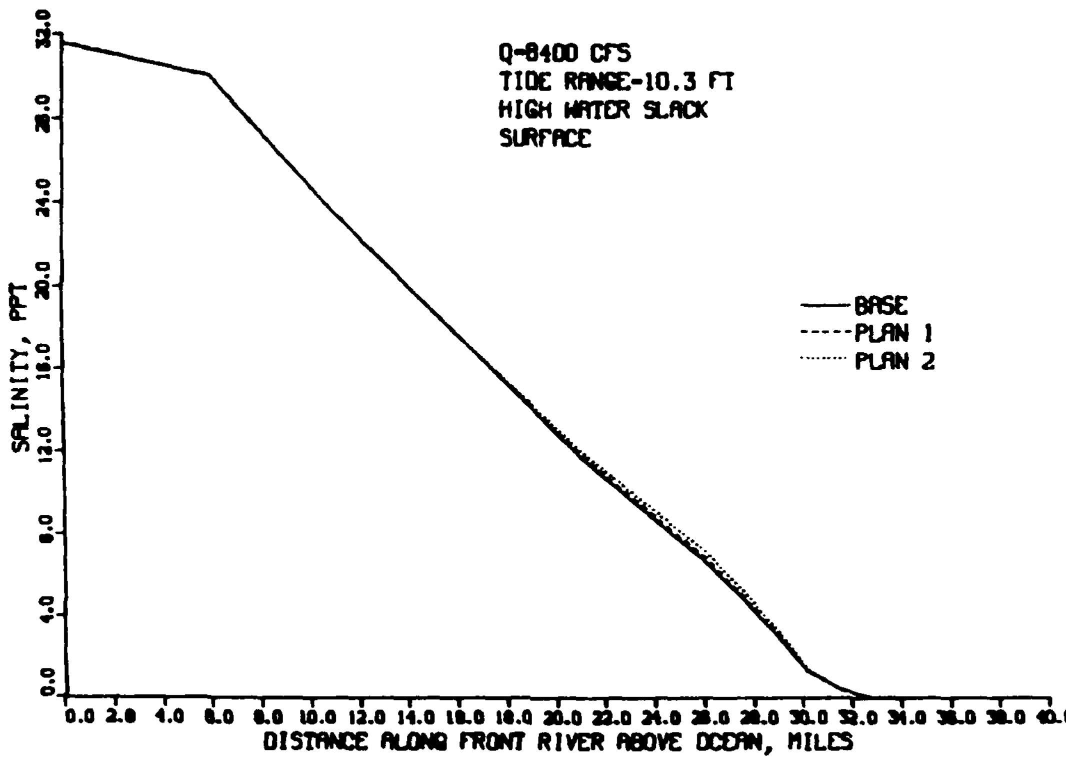


Figure 69. Salinity profile along Front River, 8,400-cfs discharge, 10.3-ft tide range, high-water slack, surface

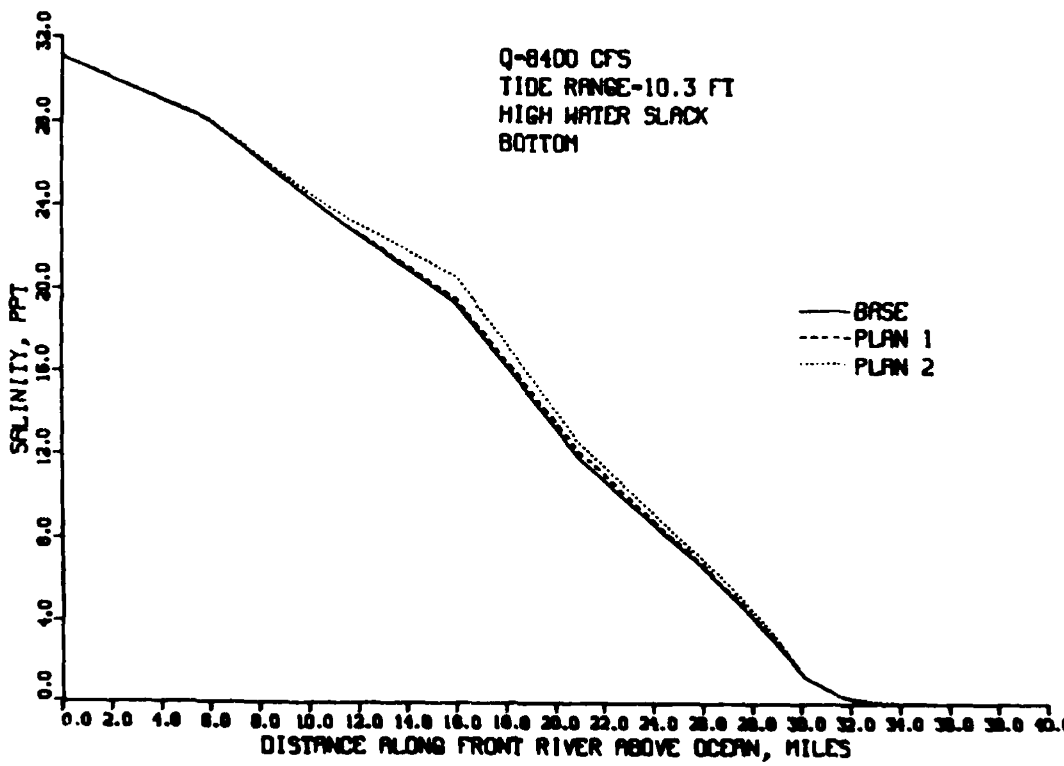


Figure 70. Salinity profile along Front River, 8,400-cfs discharge, 10.3-ft tide range, high-water slack, bottom

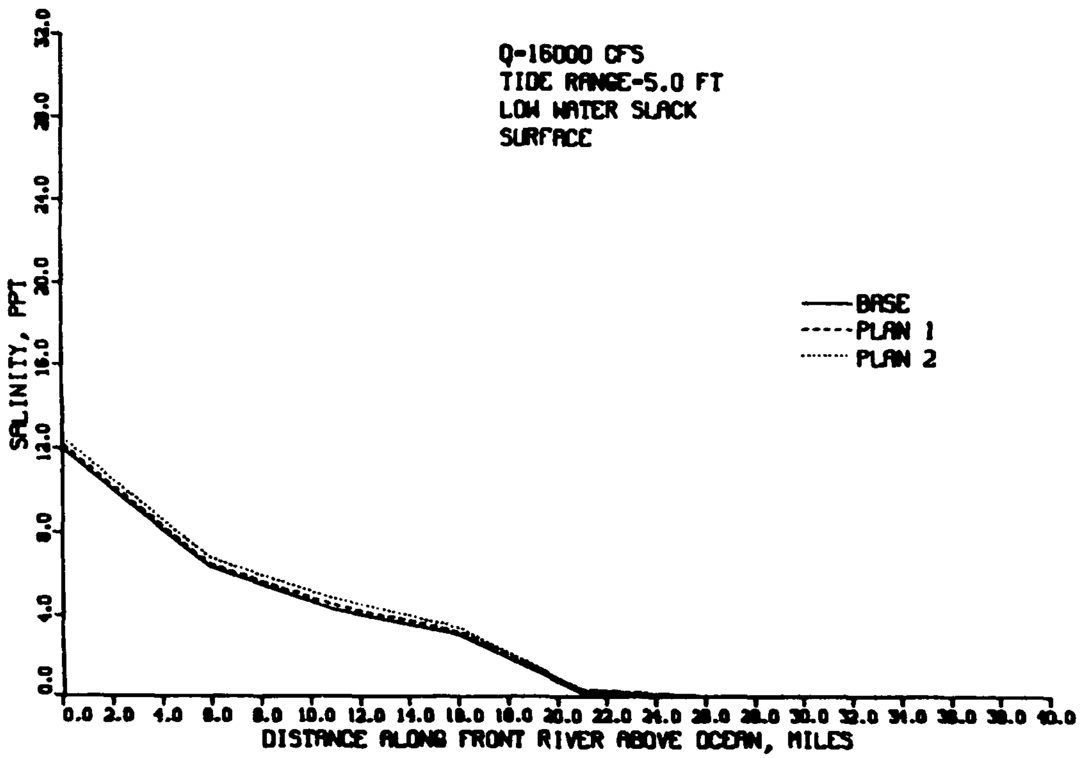


Figure 71. Salinity profile along Front River, 16,000-cfs discharge, 5-ft tide range, low-water slack, surface

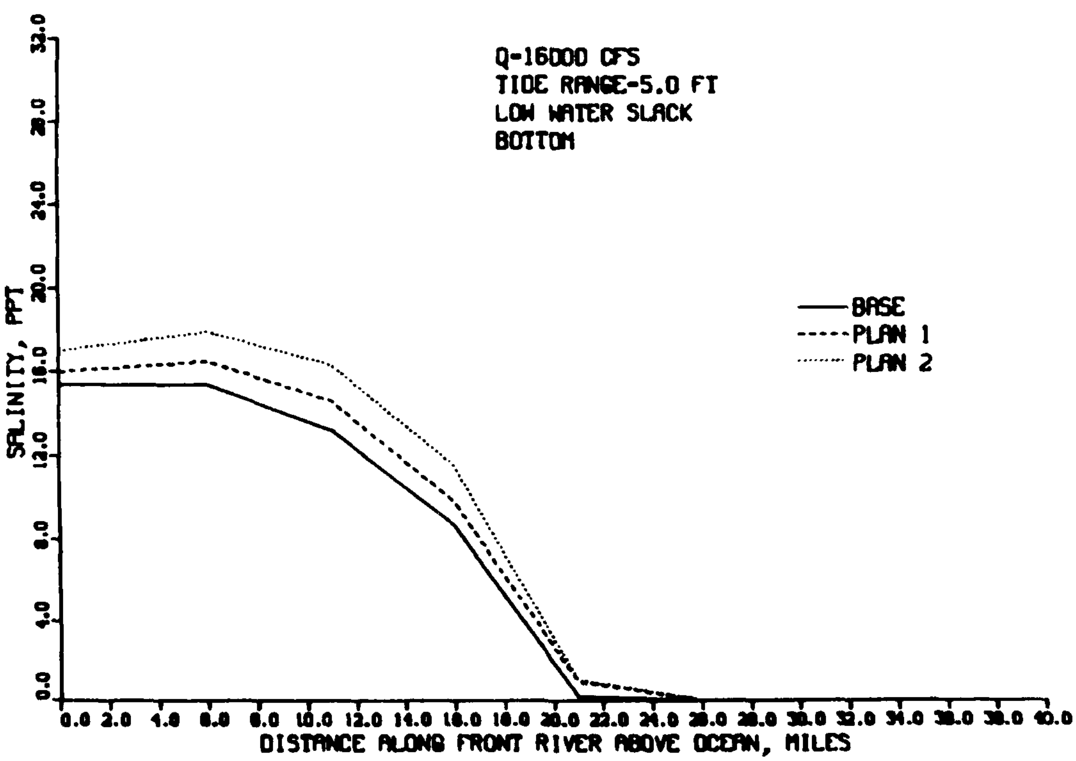


Figure 72. Salinity profile along Front River, 16,000-cfs discharge, 5-ft tide range, low-water slack, bottom

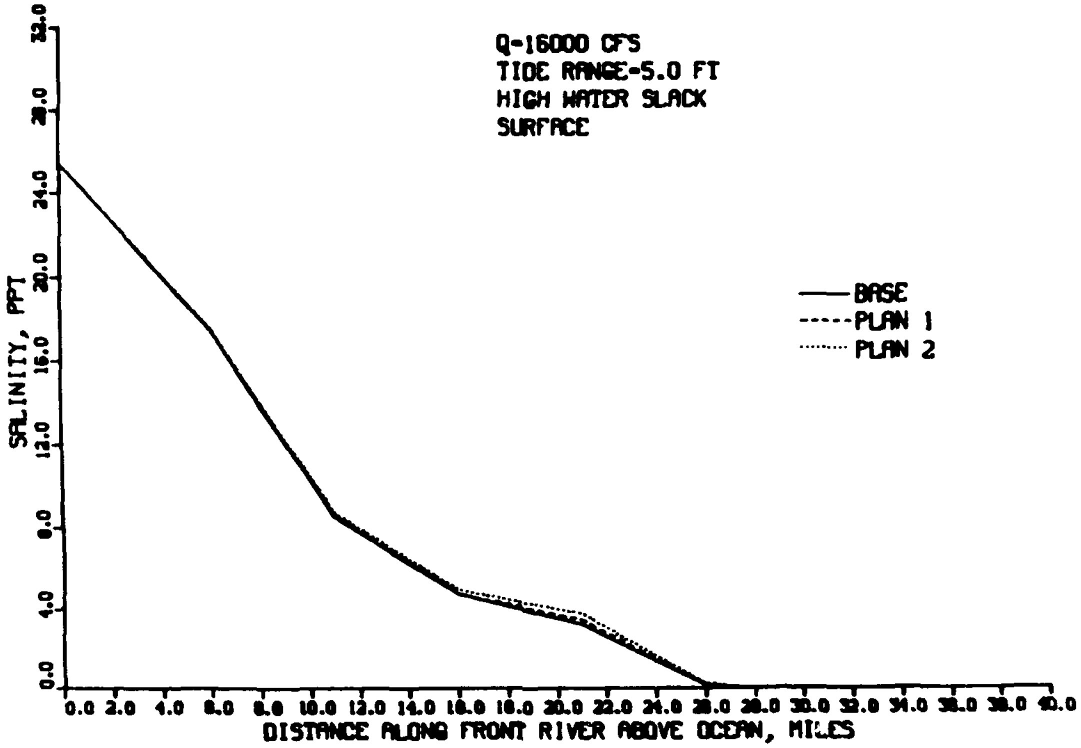


Figure 73. Salinity profile along Front River, 16,000-cfs discharge, 5-ft tide range, high-water slack, surface

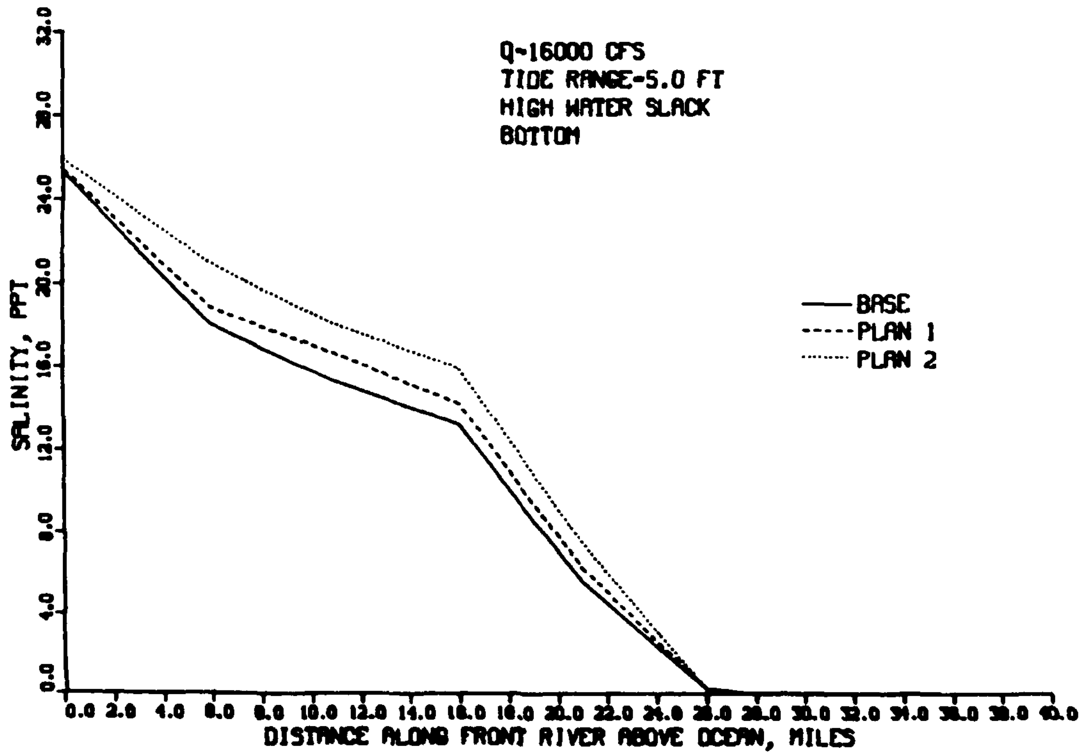


Figure 74. Salinity profile along Front River, 16,000-cfs discharge, 5-ft tide range, high-water slack, bottom

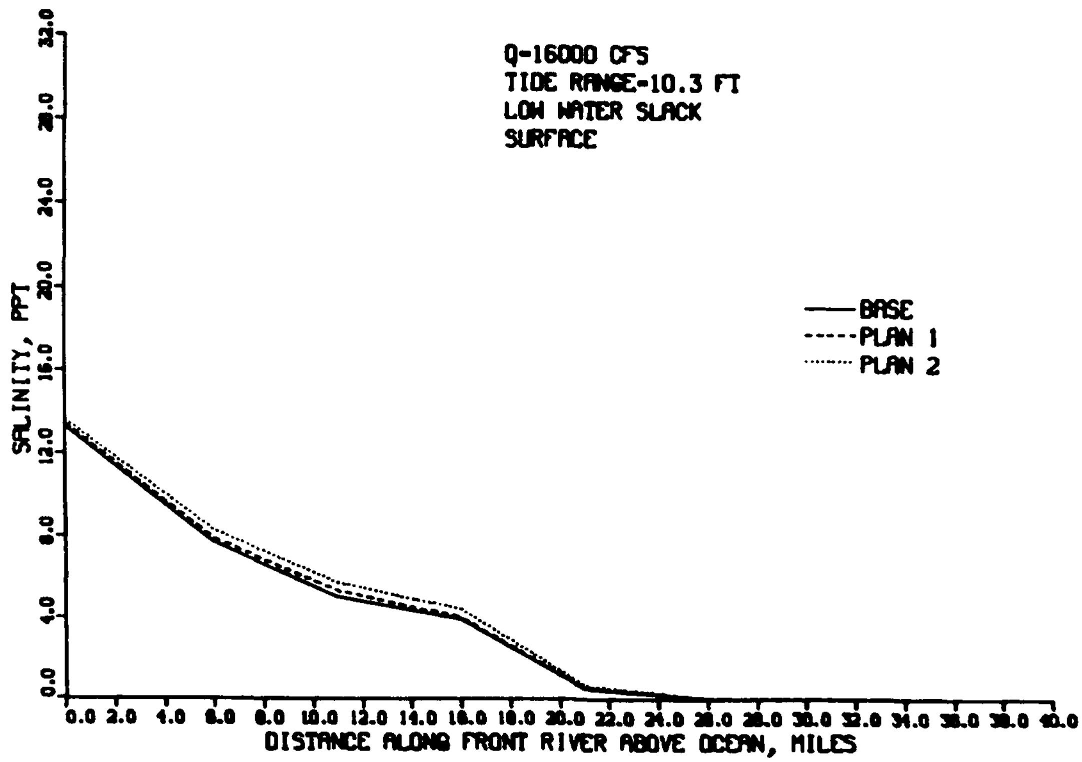


Figure 75. Salinity profile along Front River, 16,000-cfs discharge, 10.3-ft tide range, low-water slack, surface

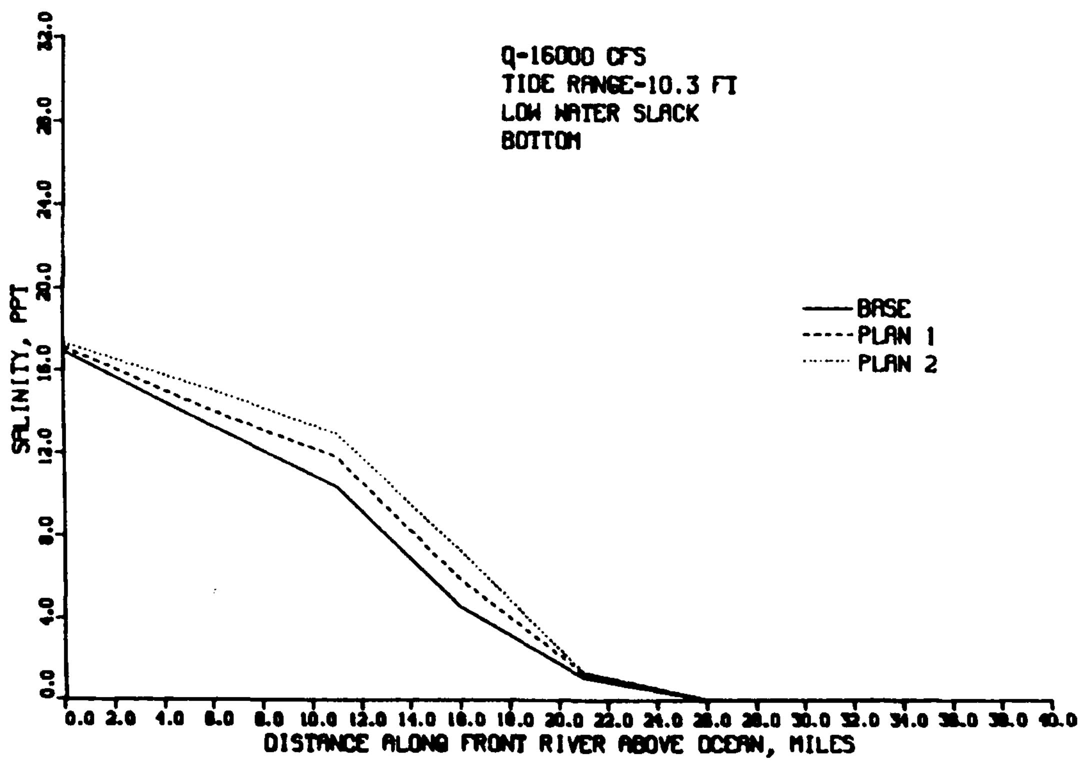


Figure 76. Salinity profile along Front River, 16,000-cfs discharge, 10.3-ft tide range, low-water slack, bottom

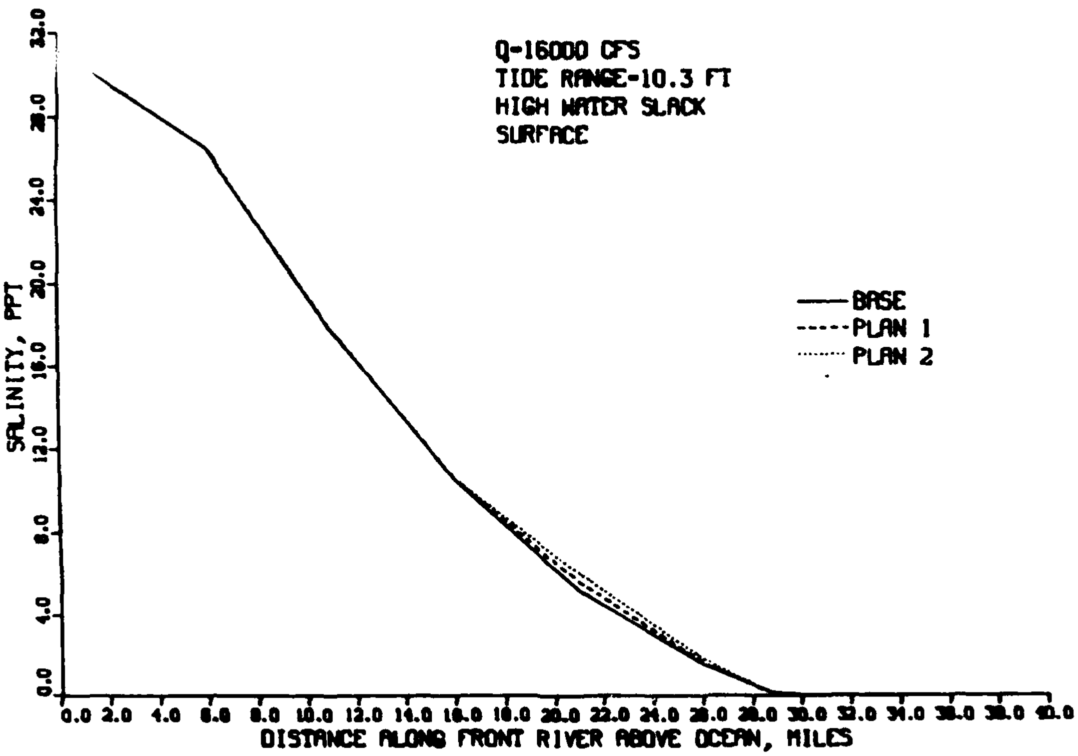


Figure 77. Salinity profile along Front River, 16,000-cfs discharge, 10.3-ft tide range, high-water slack, surface

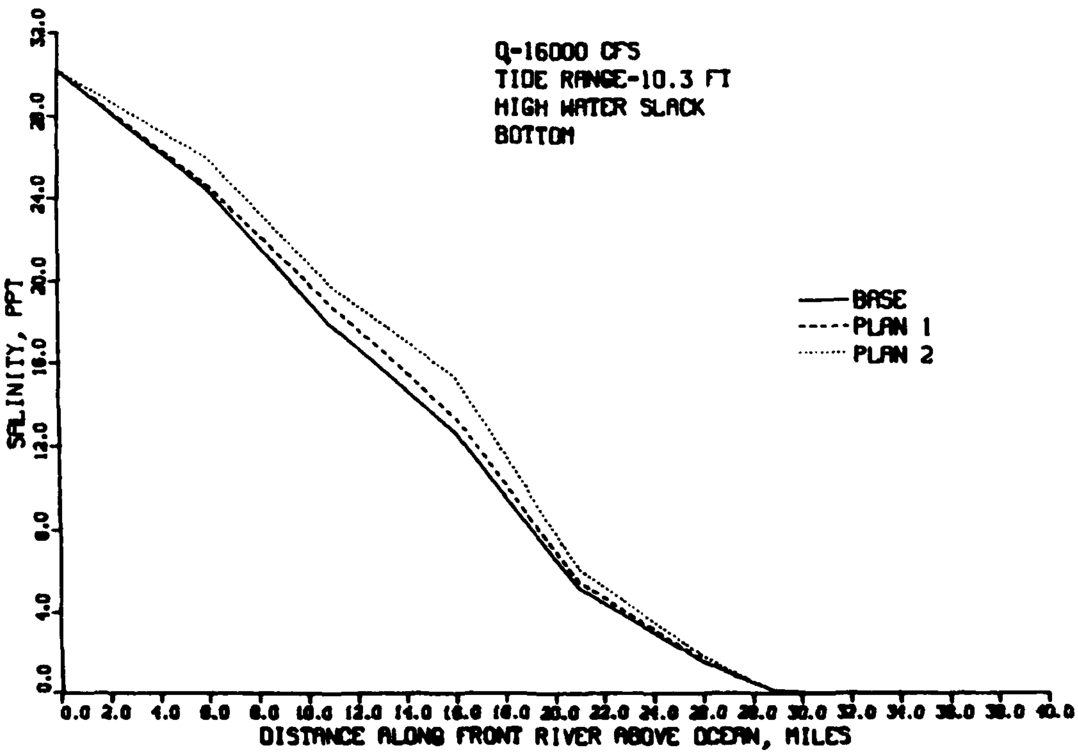


Figure 78. Salinity profile along Front River, 16,000-cfs discharge, 10.3-ft tide range, high-water slack, bottom

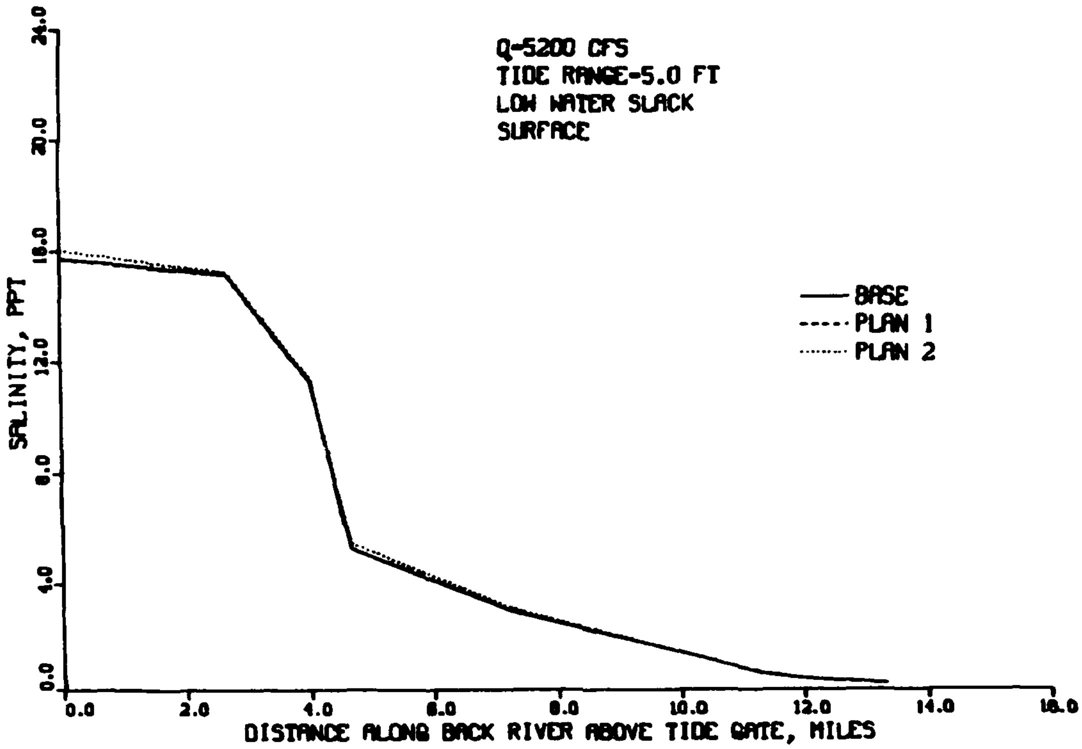


Figure 79. Salinity profile upstream of tide gate, 5,200-cfs discharge, 5-ft tide range, low-water slack, surface

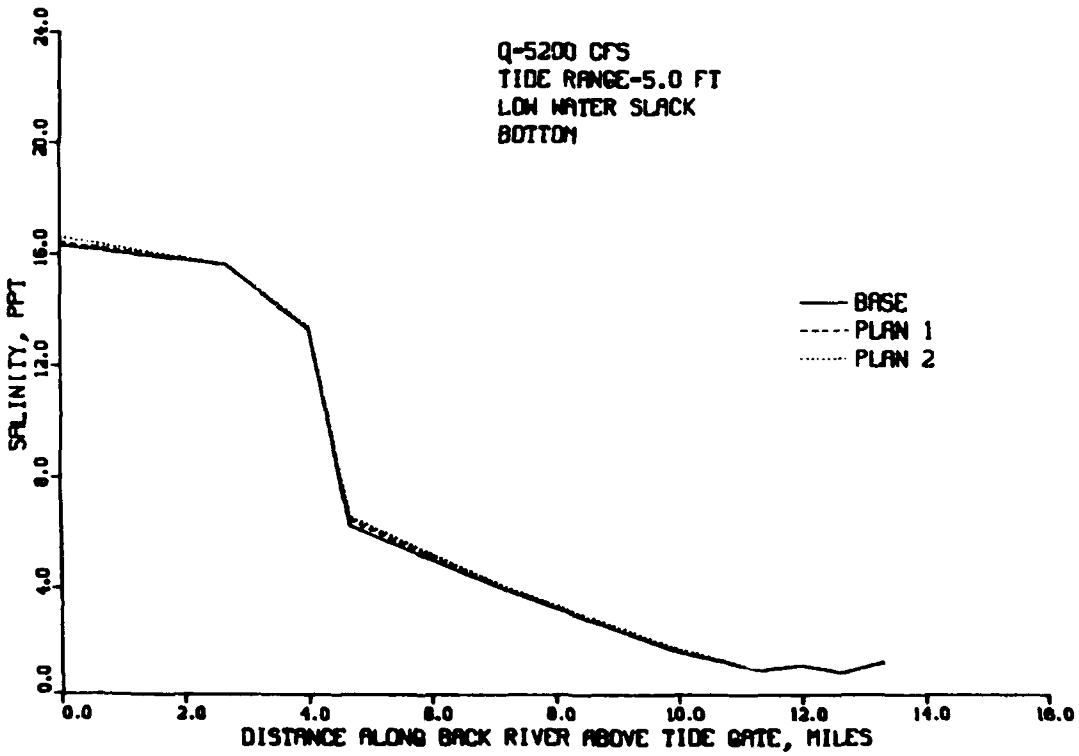


Figure 80. Salinity profile upstream of tide gate, 5,200-cfs discharge, 5-ft tide range, low-water slack, bottom

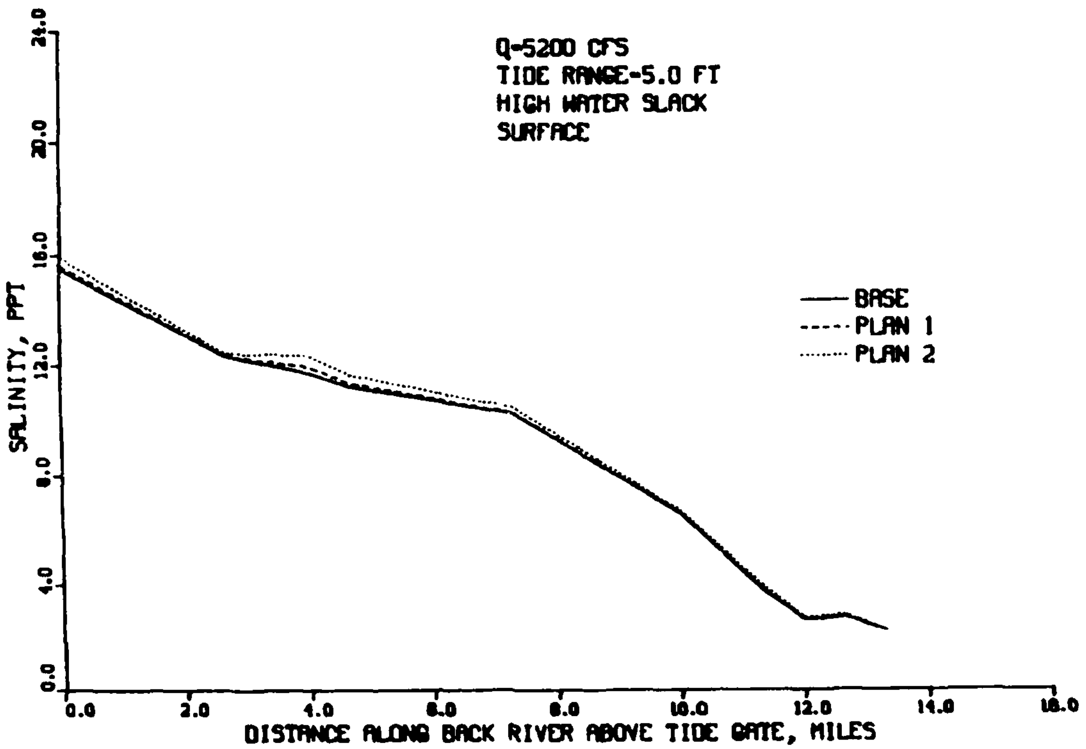


Figure 81. Salinity profile upstream of tide gate, 5,200-cfs discharge, 5-ft tide range, high-water slack, surface

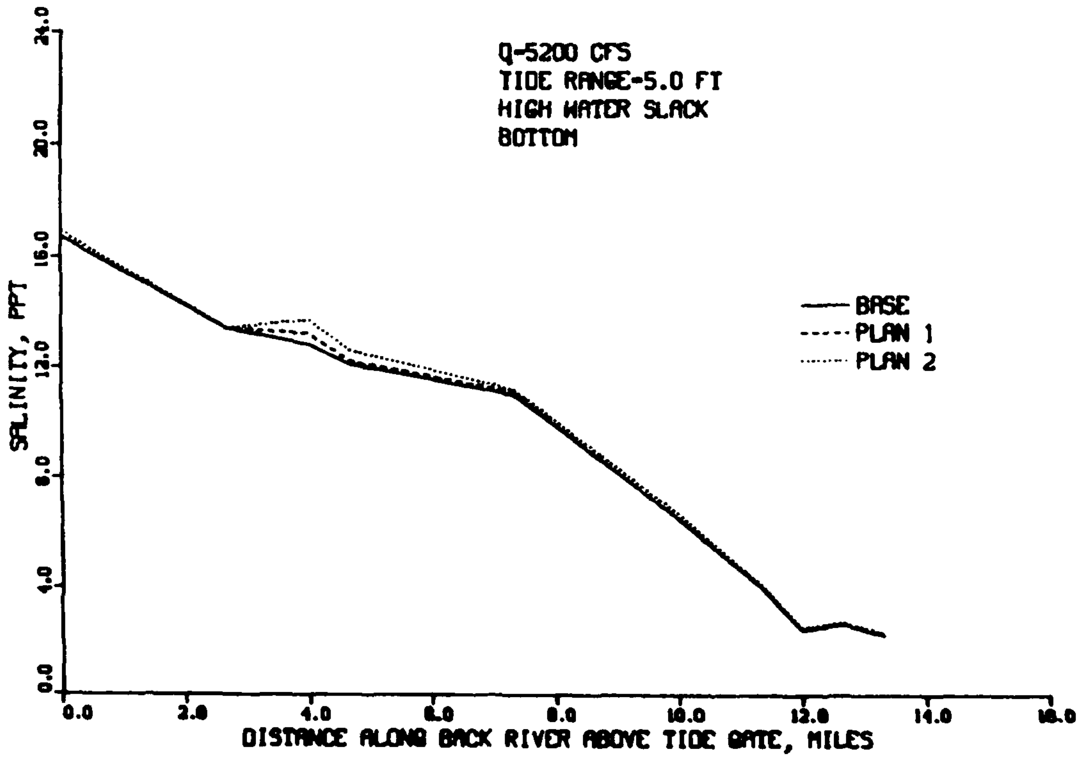


Figure 82. Salinity profile upstream of tide gate, 5,200-cfs discharge, 5-ft tide range, high-water slack, bottom

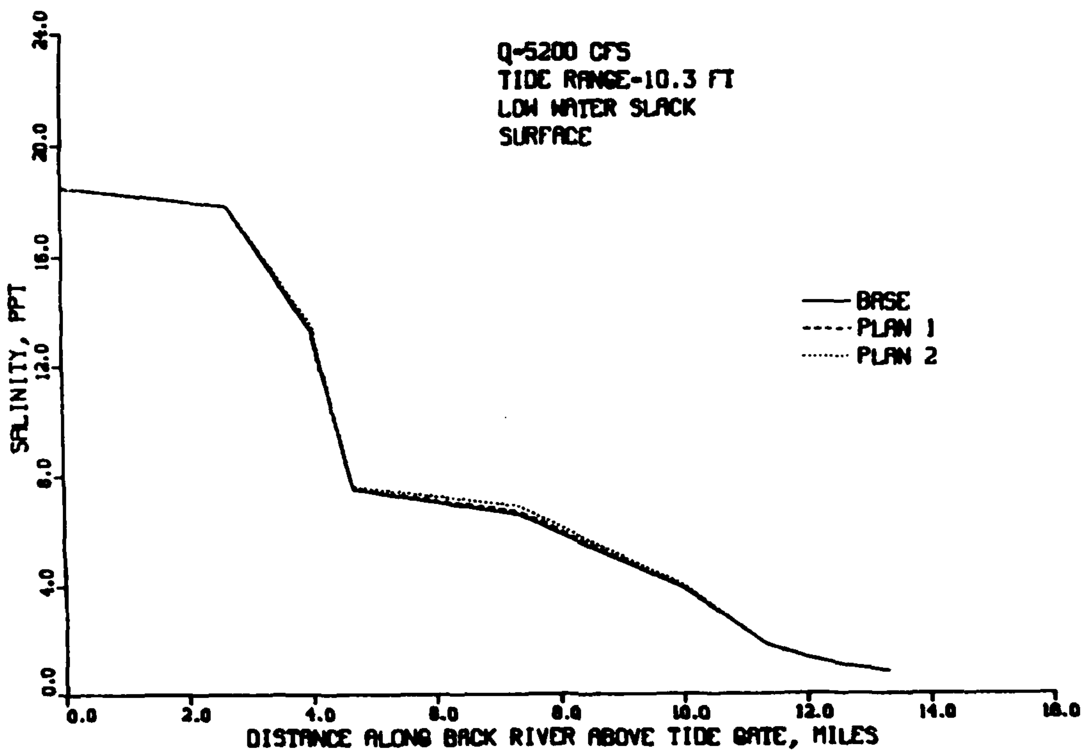


Figure 83. Salinity profile upstream of tide gate, 5,200-cfs discharge, 10.3-ft tide range, low-water slack, surface

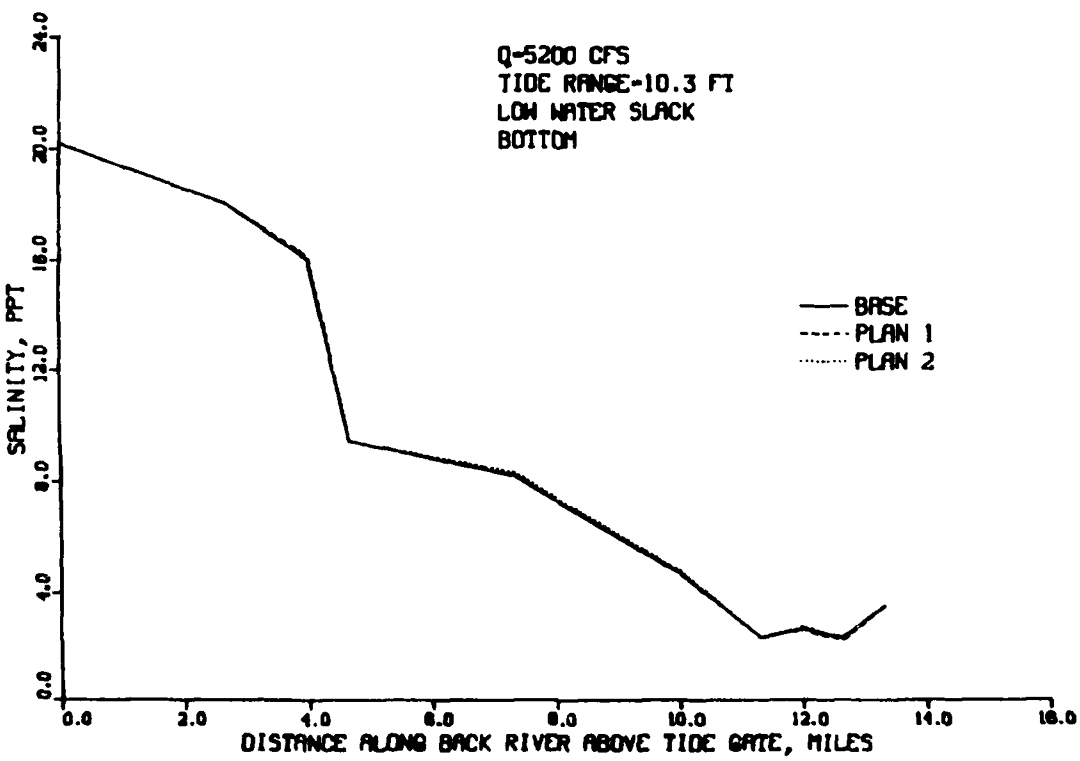


Figure 84. Salinity profile upstream of tide gate, 5,200-cfs discharge, 10.3-ft tide range, low-water slack, bottom

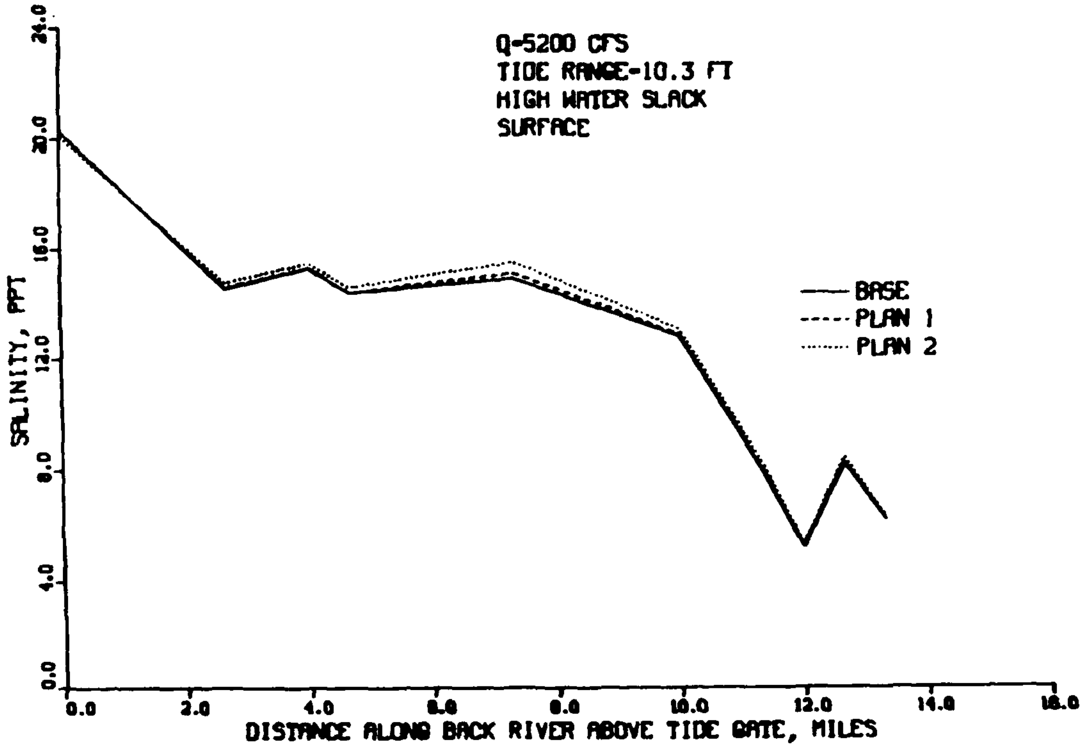


Figure 85. Salinity profile upstream of tide gate, 5,200-cfs discharge, 10.3-ft tide range, high-water slack, surface

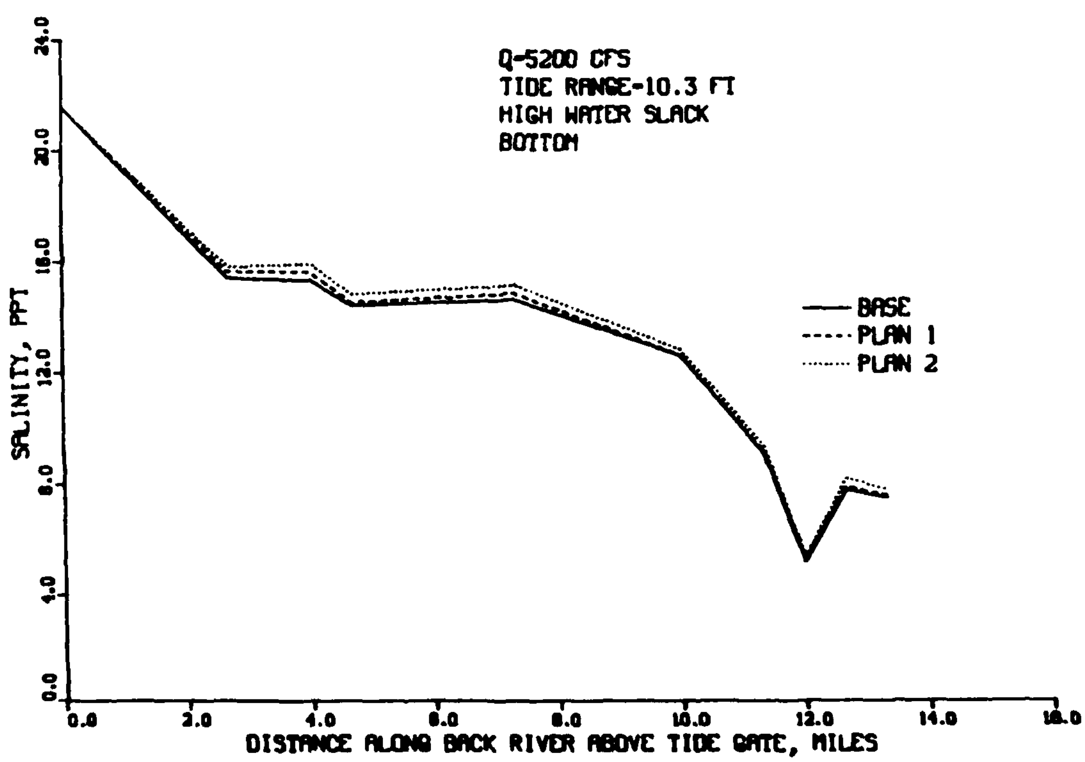


Figure 86. Salinity profile upstream of tide gate, 5,200-cfs discharge, 10.3-ft tide range, high-water slack, bottom

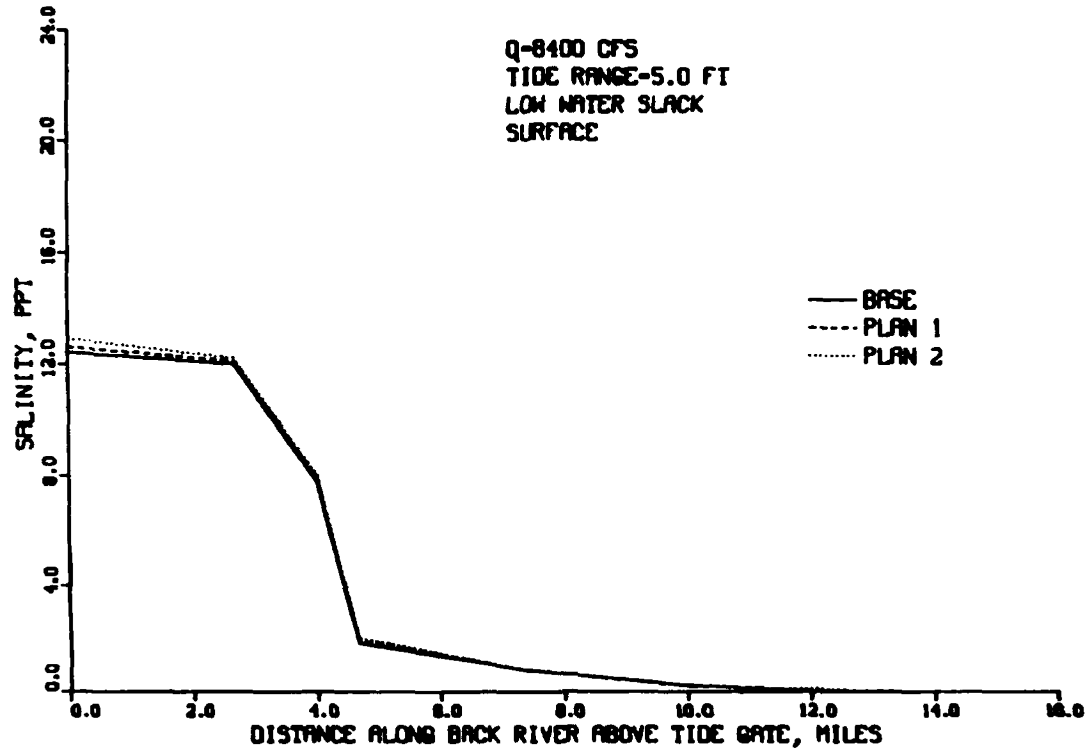


Figure 87. Salinity profile upstream of tide gate, 8,400-cfs discharge, 5-ft tide range, low-water slack, surface

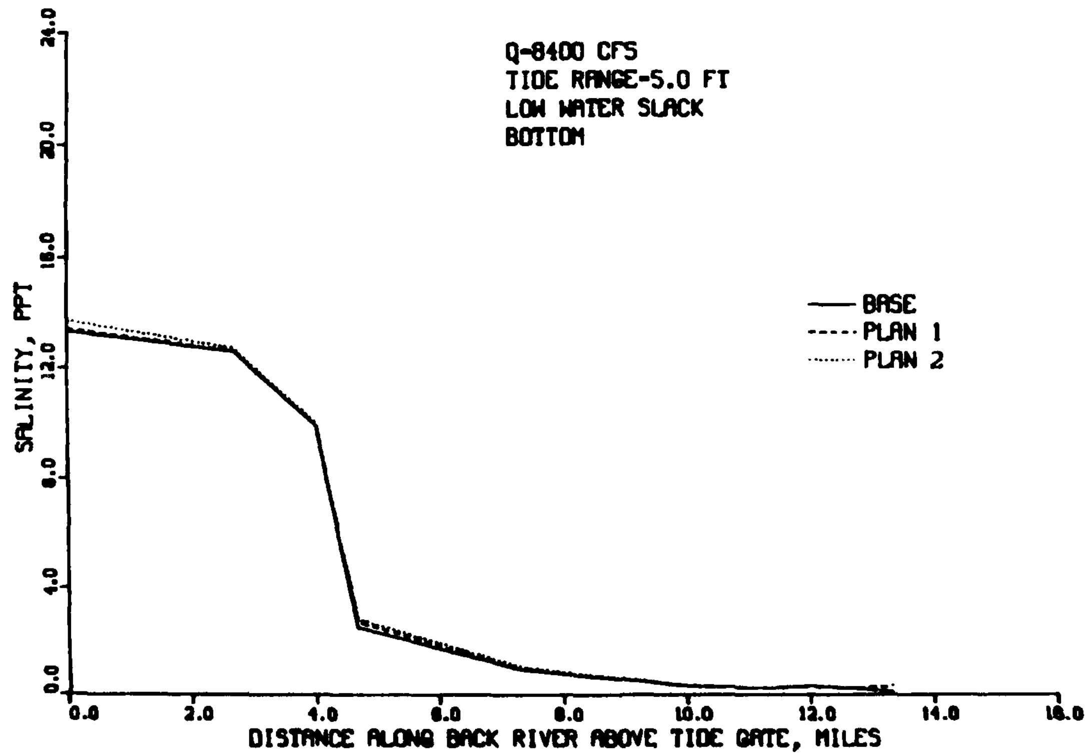


Figure 88. Salinity profile upstream of tide gate, 8,400-cfs discharge, 5-ft tide range, low-water slack, bottom

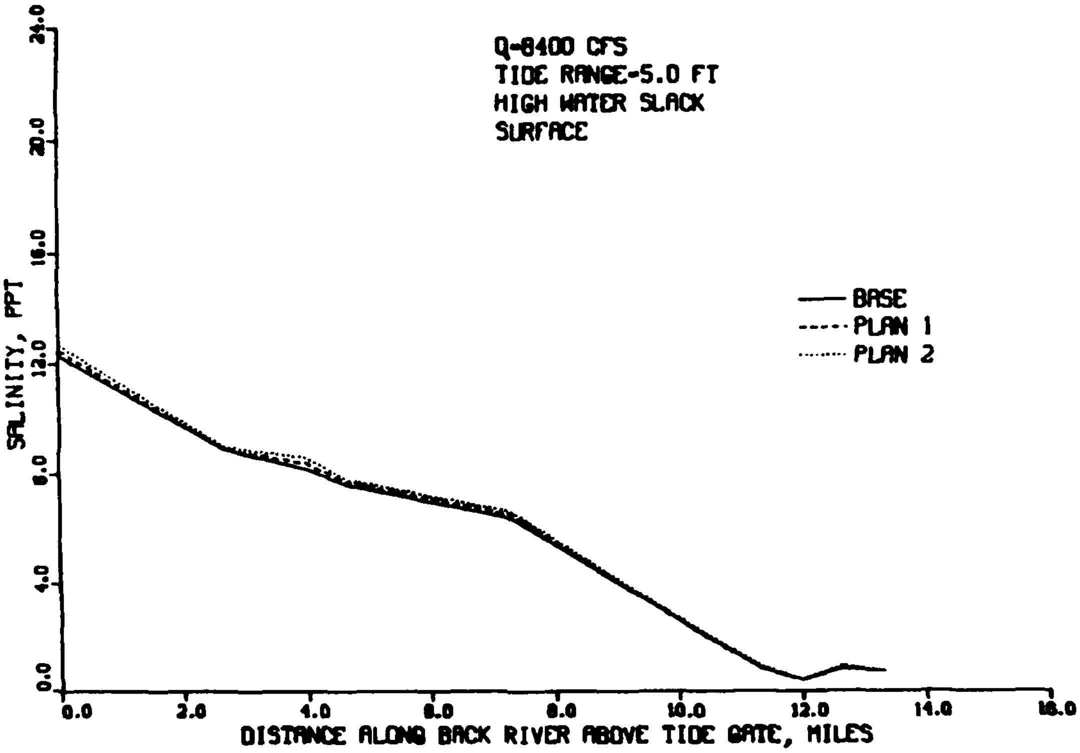


Figure 89. Salinity profile upstream of tide gate, 8,400-cfs discharge, 5-ft tide range, high-water slack, surface

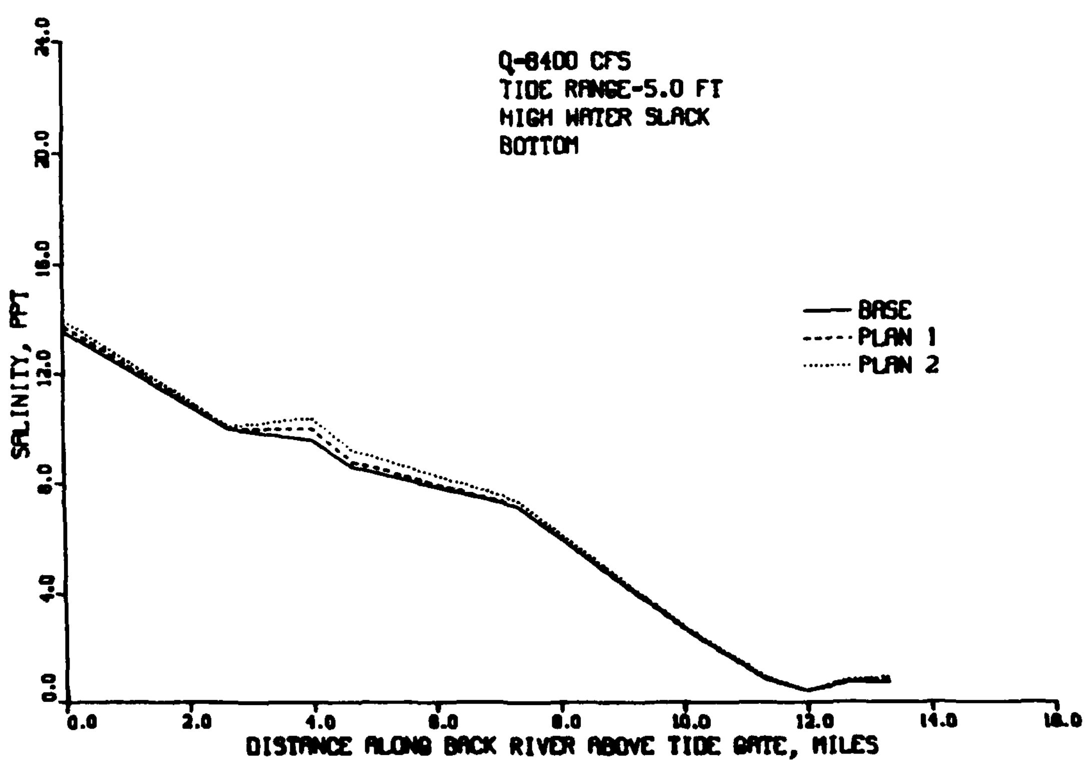


Figure 90. Salinity profile upstream of tide gate, 8,400-cfs discharge, 5-ft tide range, high-water slack, bottom

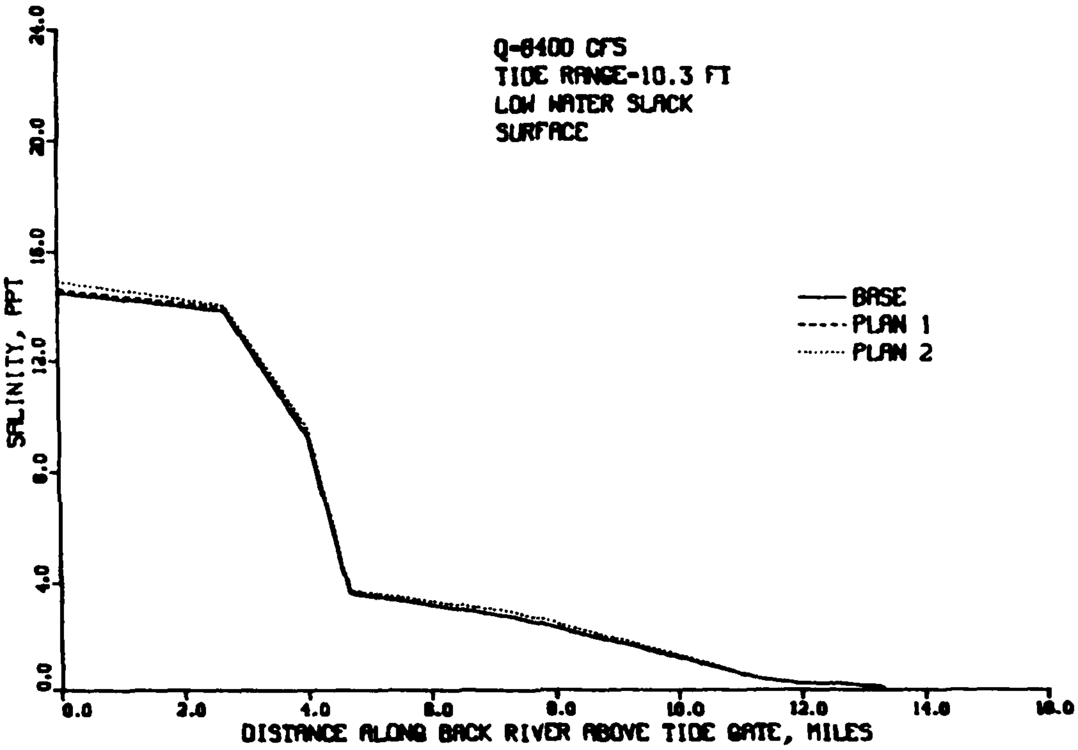


Figure 91. Salinity profile upstream of tide gate, 8,400-cfs discharge, 10.3-ft tide range, low-water slack, surface

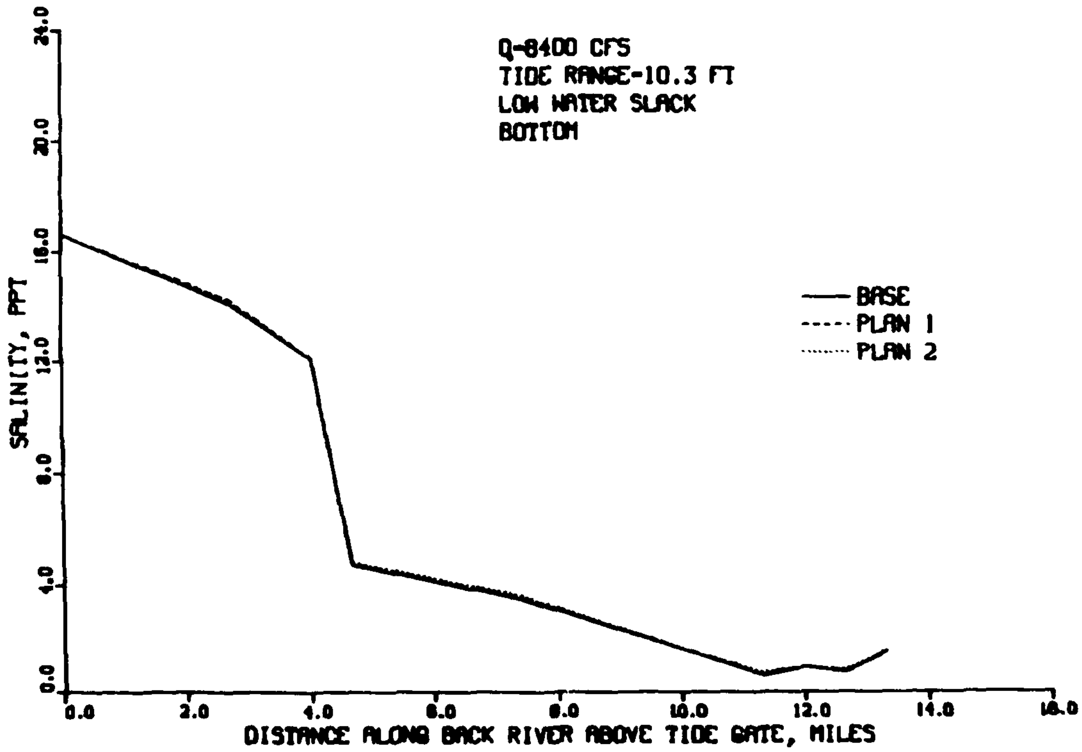


Figure 92. Salinity profile upstream of tide gate, 8,400-cfs discharge, 10.3-ft tide range, low-water slack, bottom

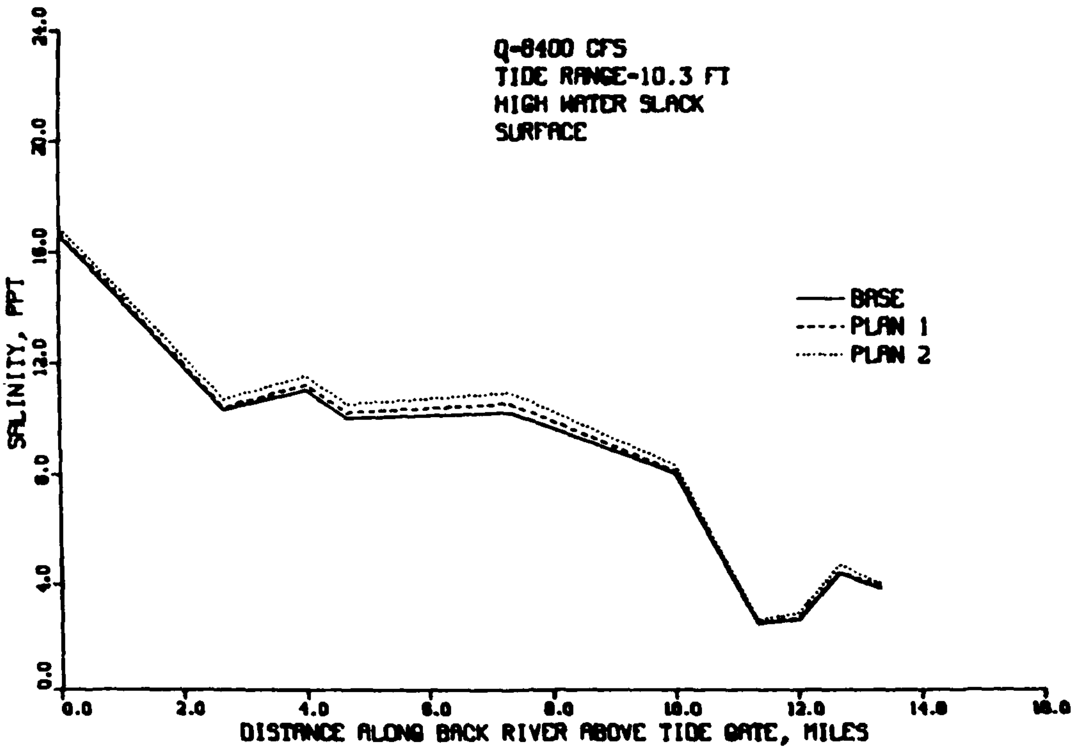


Figure 93. Salinity profile upstream of tide gate, 8,400-cfs discharge, 10.3-ft tide range, high-water slack, surface

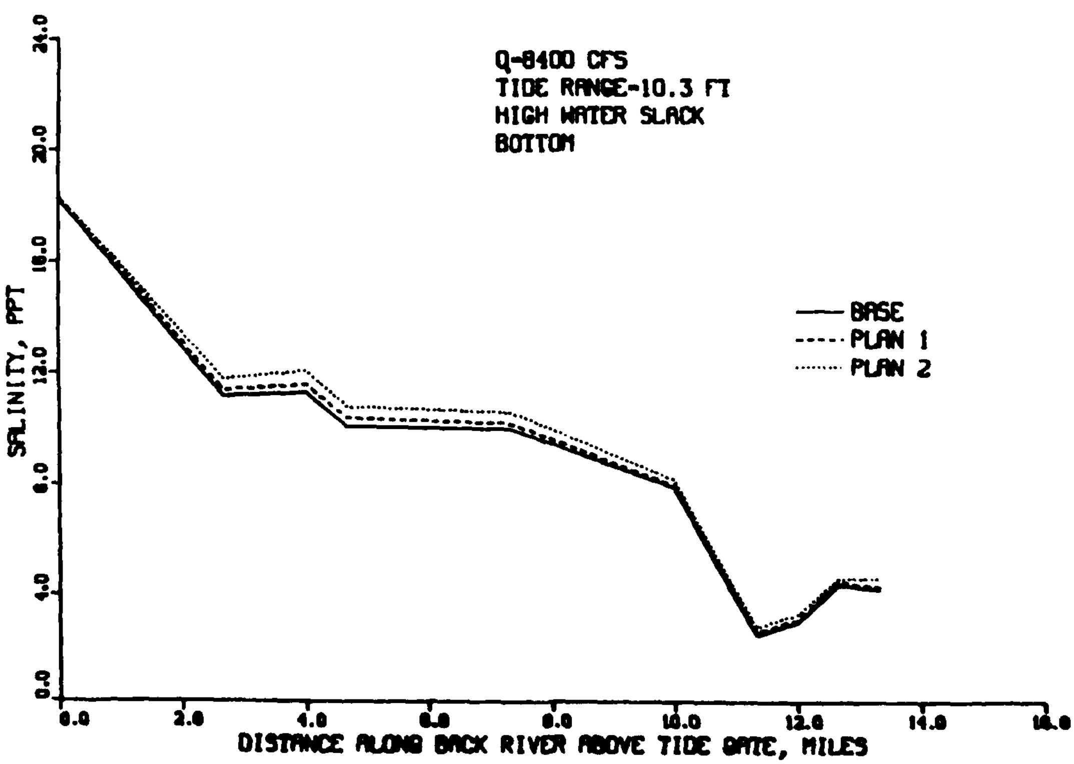


Figure 94. Salinity profile upstream of tide gate, 8,400-cfs discharge, 10.3-ft tide range, high-water slack, bottom

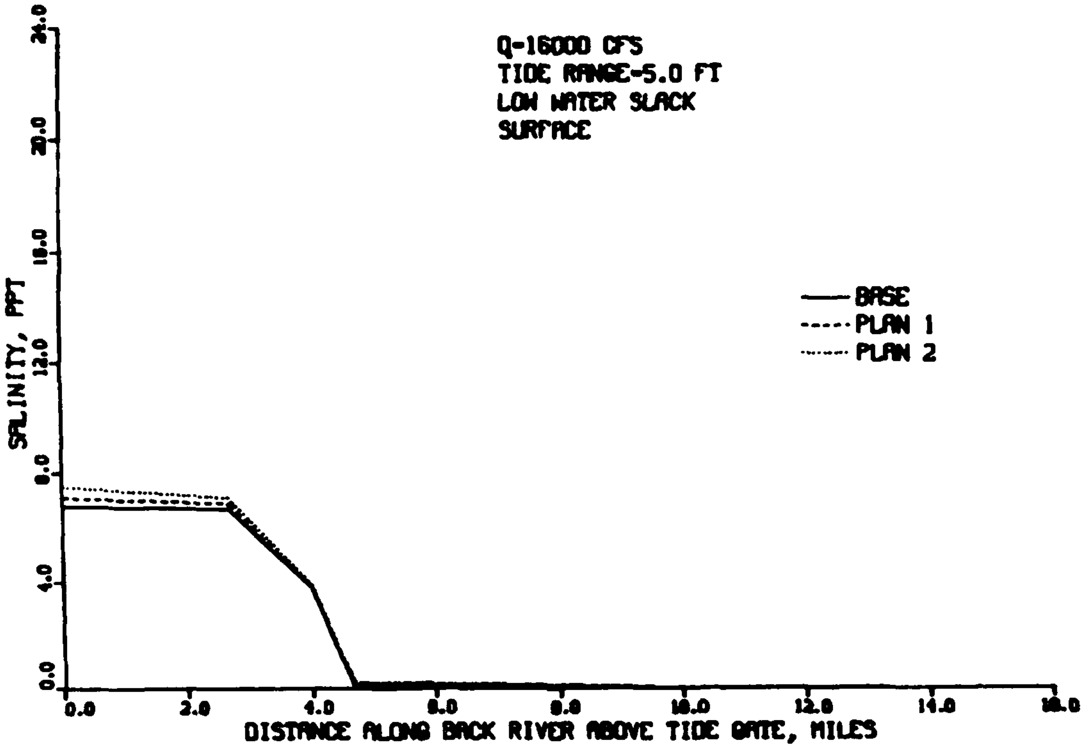


Figure 95. Salinity profile upstream of tide gate, 16,000-cfs discharge, 5-ft tide range, low-water slack, surface

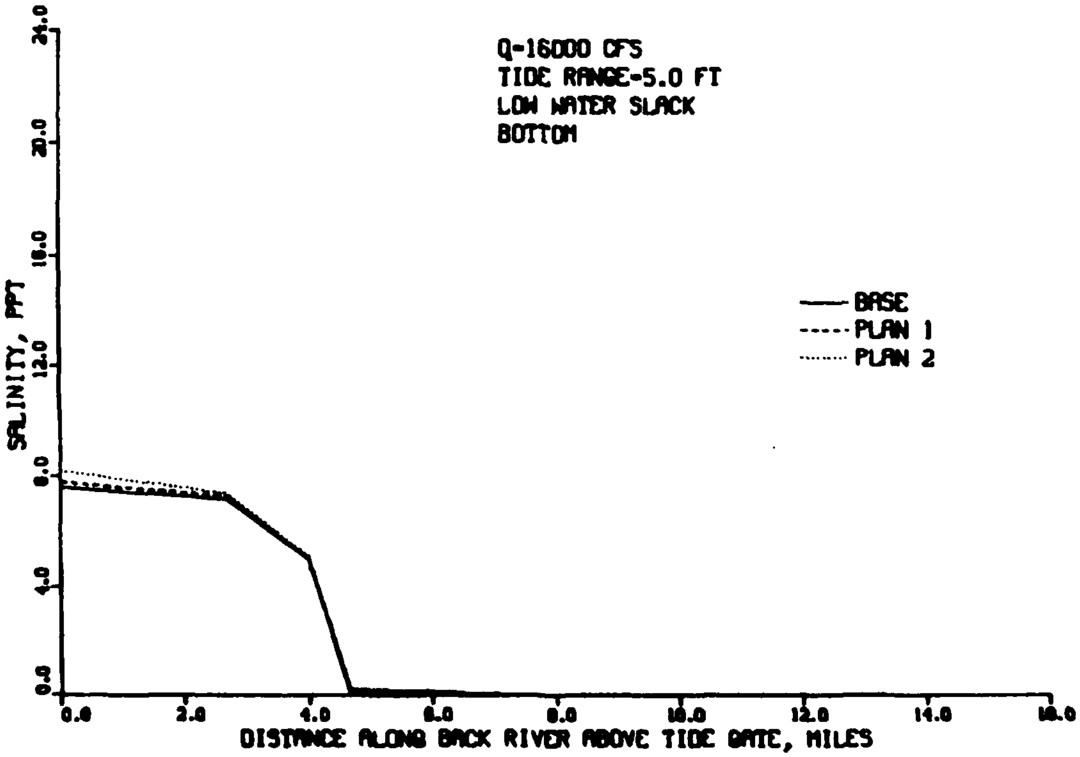


Figure 96. Salinity profile upstream of tide gate, 16,000-cfs discharge, 5-ft tide range, low-water slack, bottom

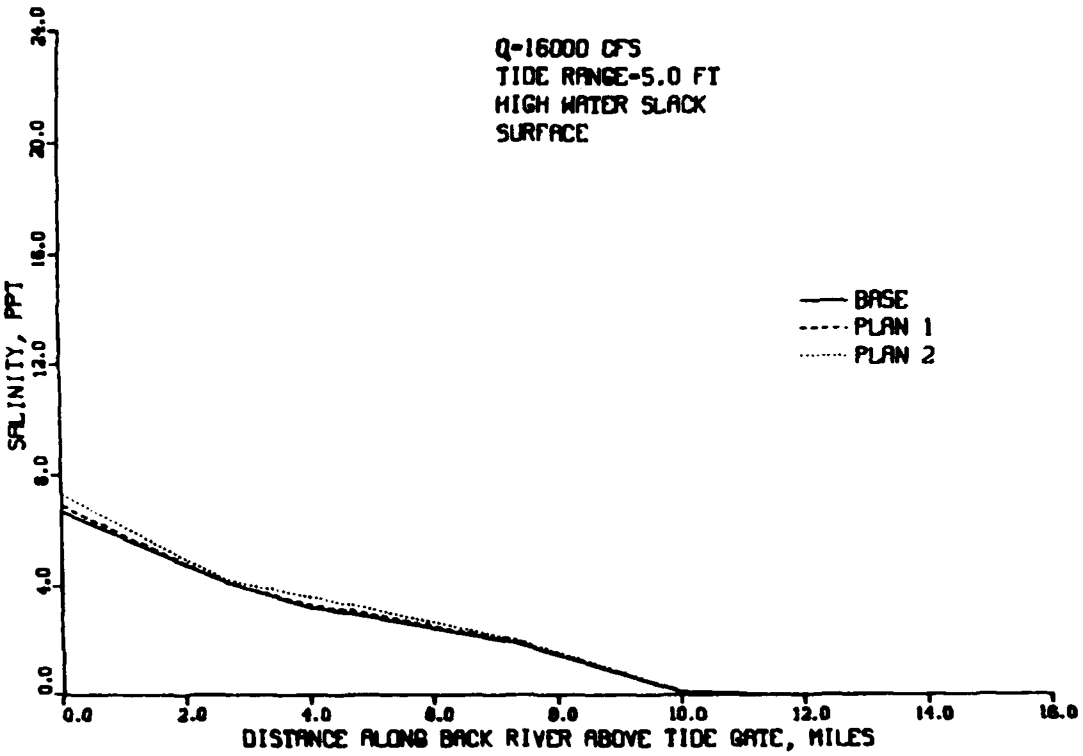


Figure 97. Salinity profile upstream of tide gate, 16,000-cfs discharge, 5-ft tide range, high-water slack, surface

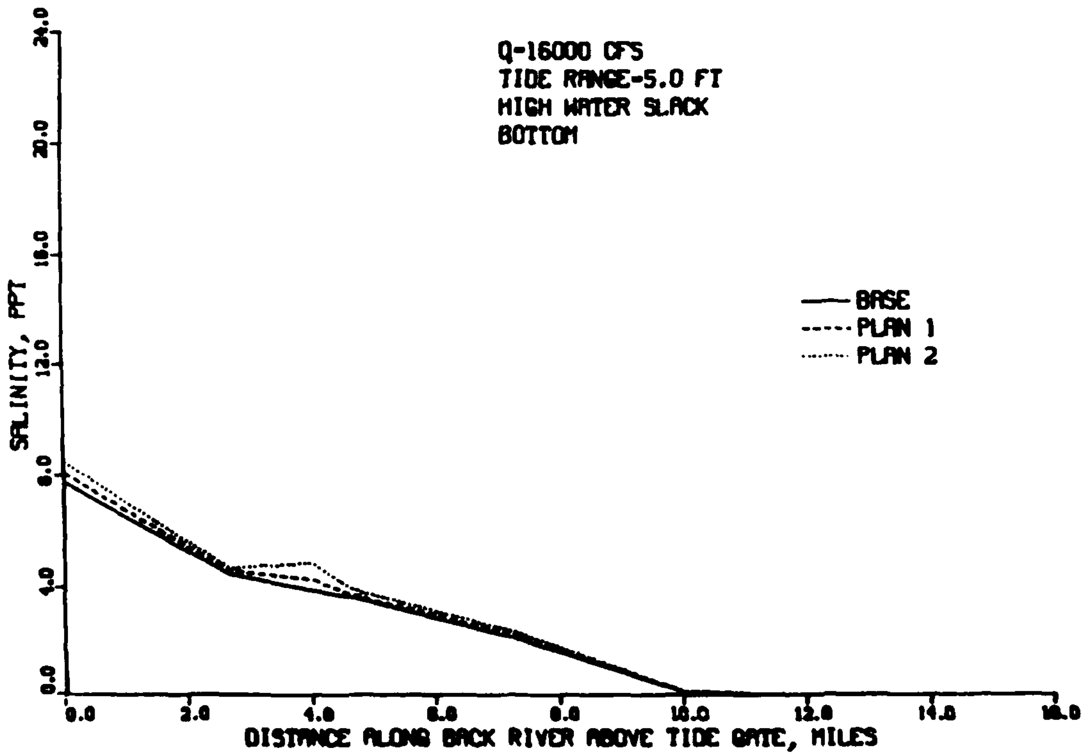


Figure 98. Salinity profile upstream of tide gate, 16,000-cfs discharge, 5-ft tide range, high-water slack, bottom

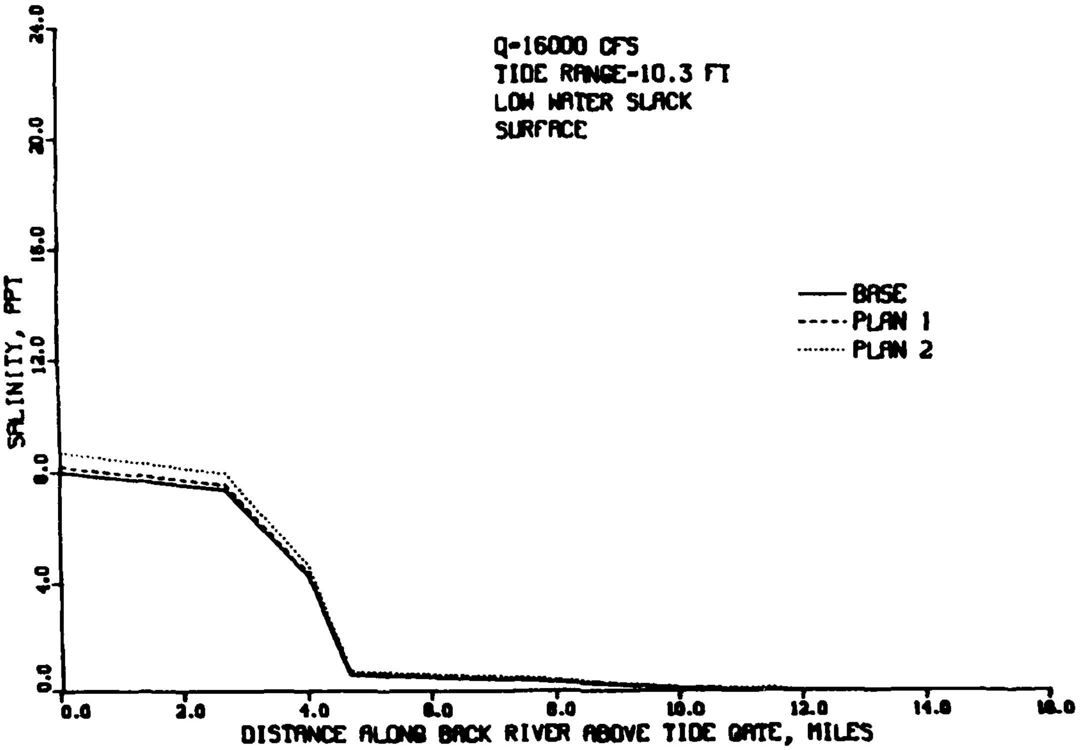


Figure 99. Salinity profile upstream of tide gate, 16,000-cfs discharge, 10.3-ft tide range, low-water slack, surface

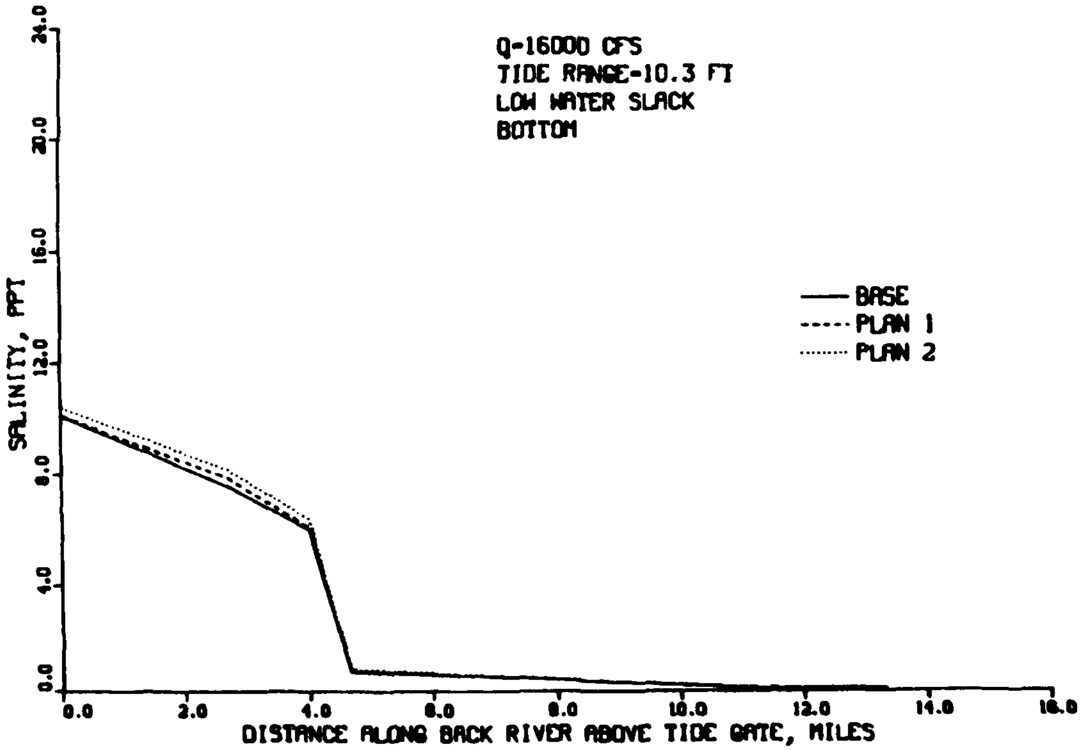


Figure 100. Salinity profile upstream of tide gate, 16,000-cfs discharge, 10.3-ft tide range, low-water slack, bottom

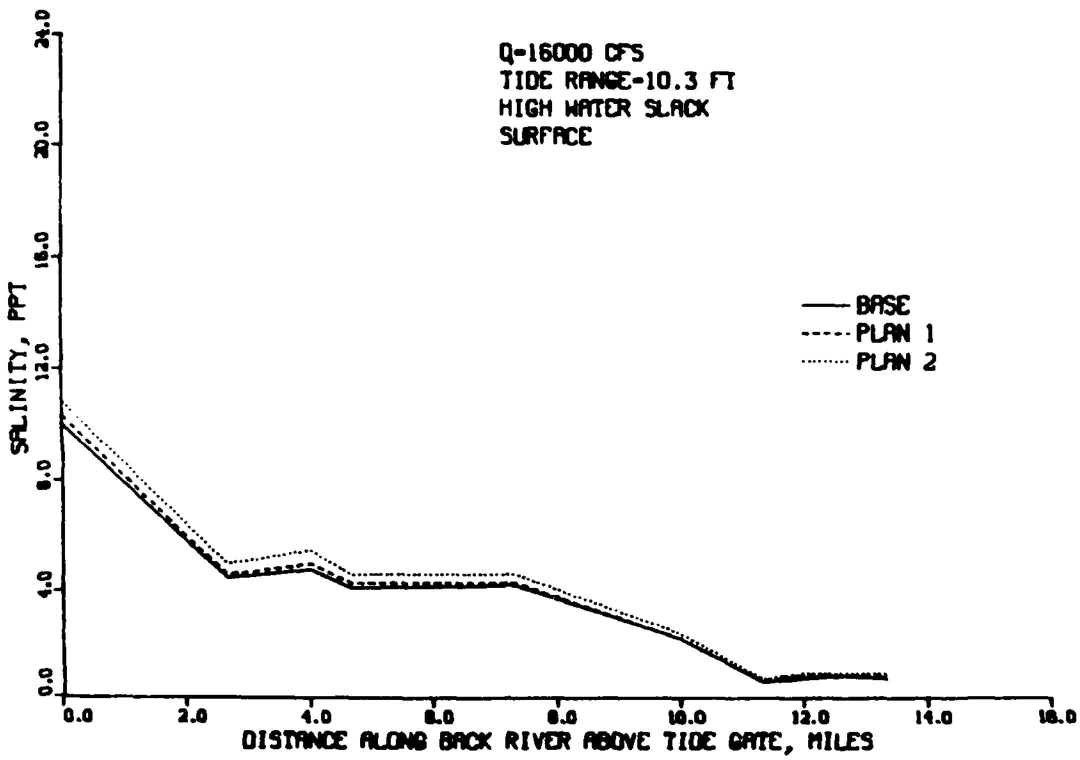


Figure 101. Salinity profile upstream of tide gate, 16,000-cfs discharge, 10.3-ft tide range, high-water slack, surface

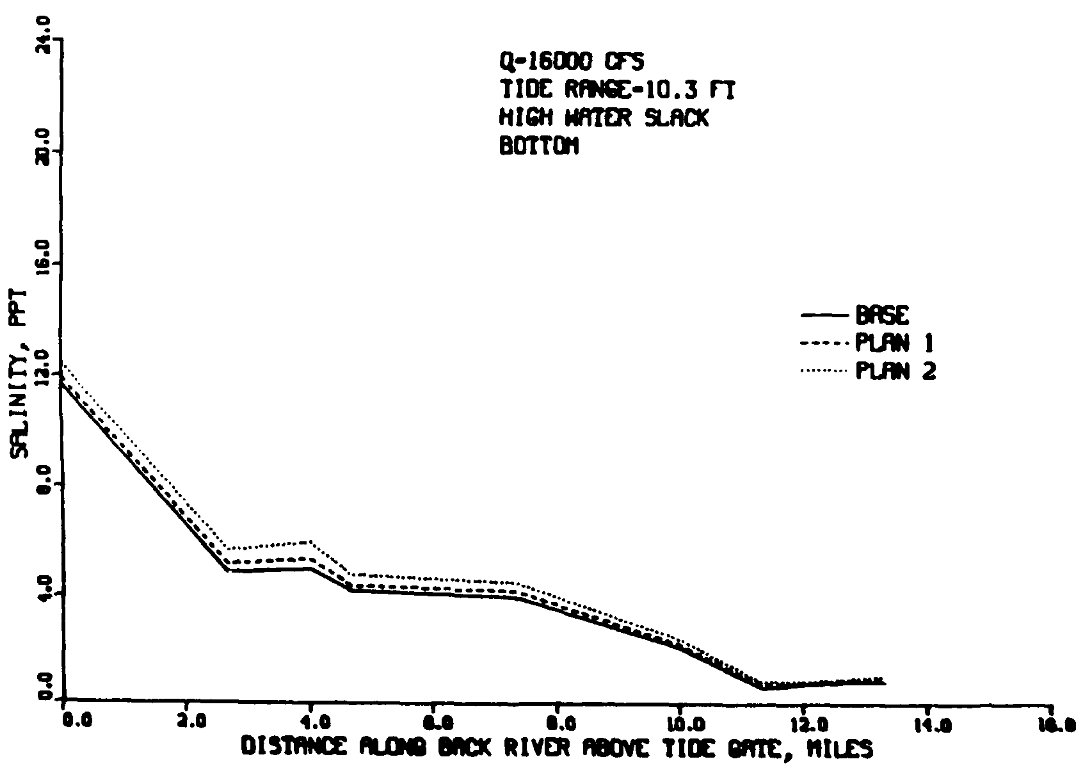


Figure 102. Salinity profile upstream of tide gate, 16,000-cfs discharge, 10.3-ft tide range, high-water slack, bottom

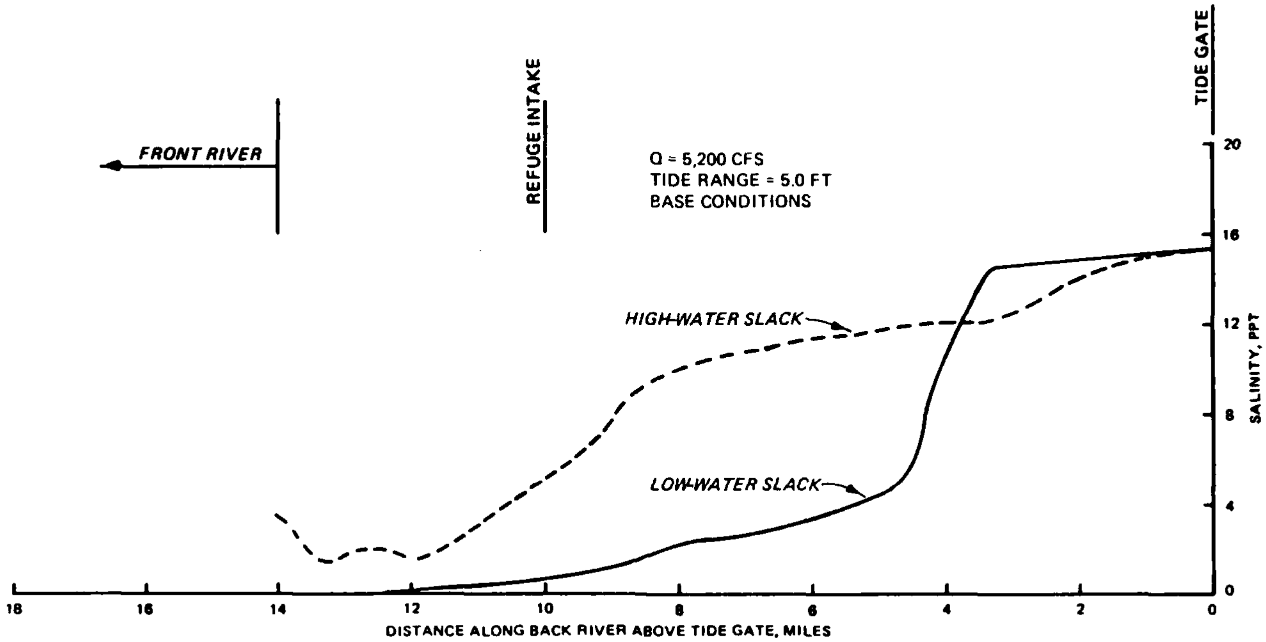


Figure 103. Comparison of high- and low-water slack salinity profiles upstream of the tide gate, 5,200-cfs discharge, 5-ft tide range, base conditions

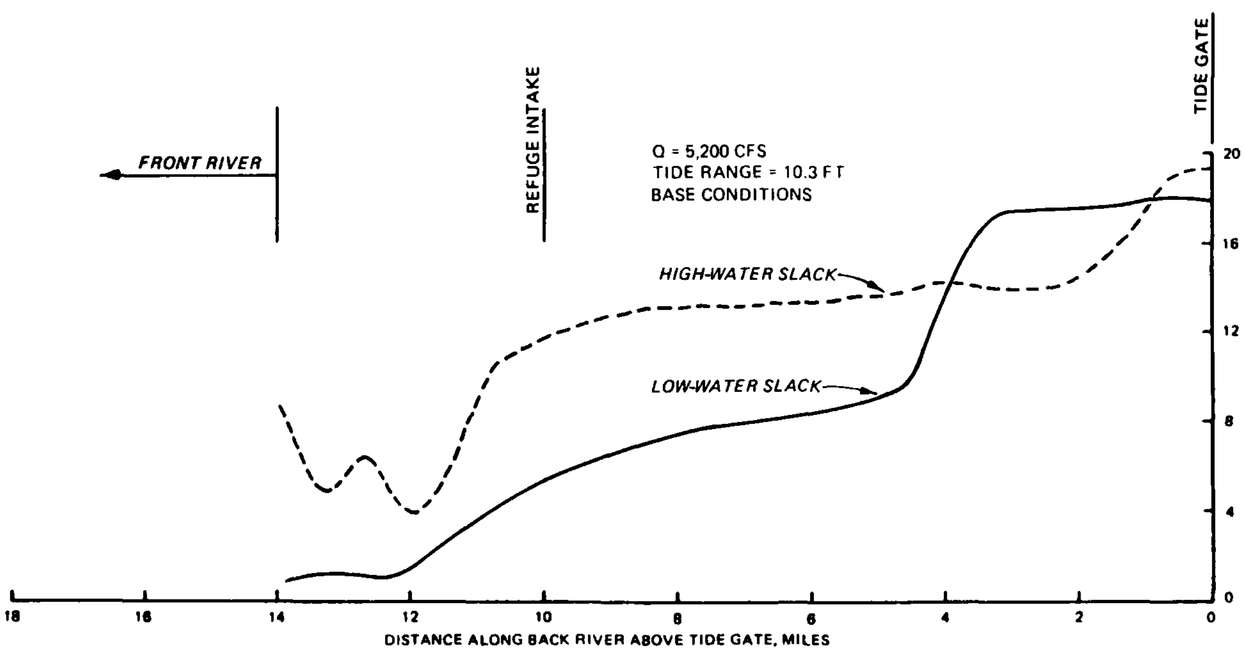


Figure 104. Comparison of high- and low-water slack salinity profiles upstream of the tide gate, 5,200-cfs discharge, 10.3-ft tide range, base conditions

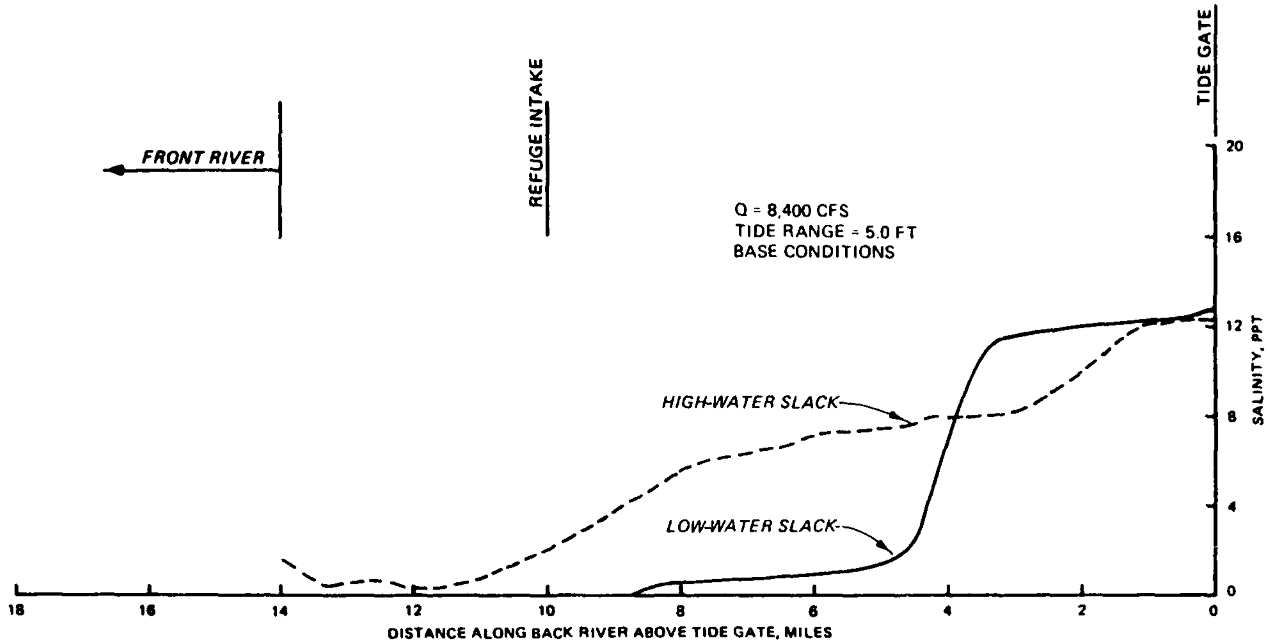


Figure 105. Comparison of high- and low-water slack salinity profiles upstream of the tide gate, 8,400-cfs discharge, 5-ft tide range, base conditions

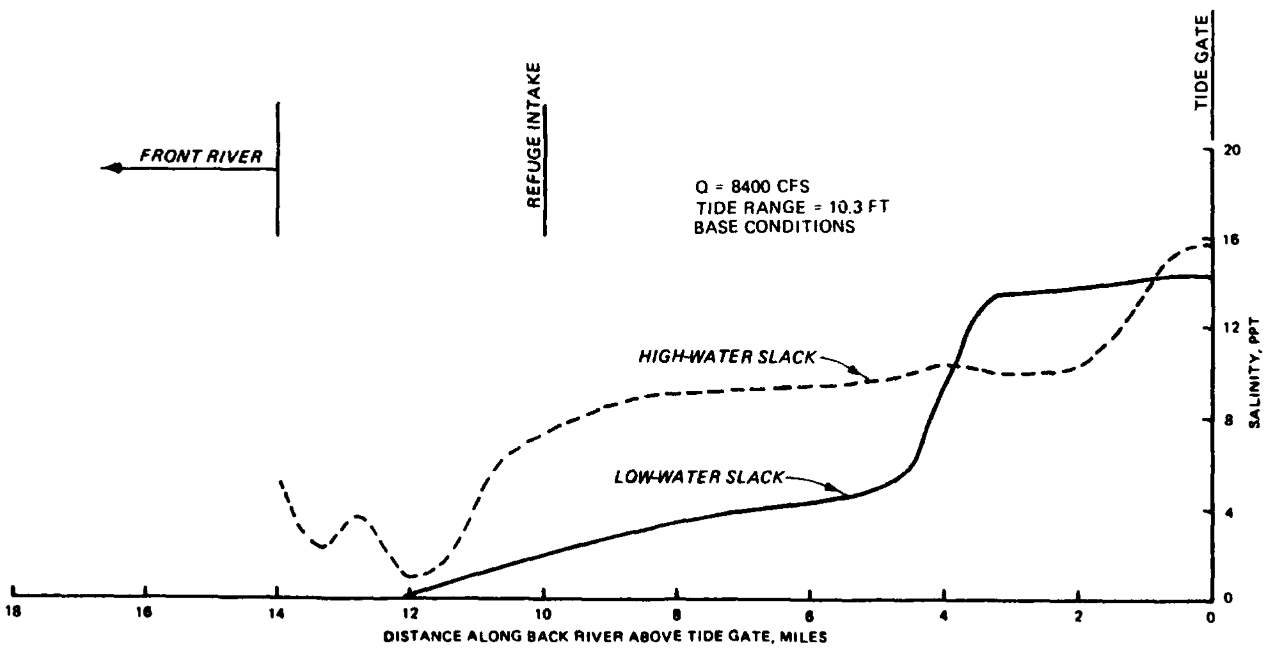


Figure 106. Comparison of high- and low-water slack salinity profiles upstream of the tide gate, 8,400-cfs discharge, 10.3-ft tide range, base conditions

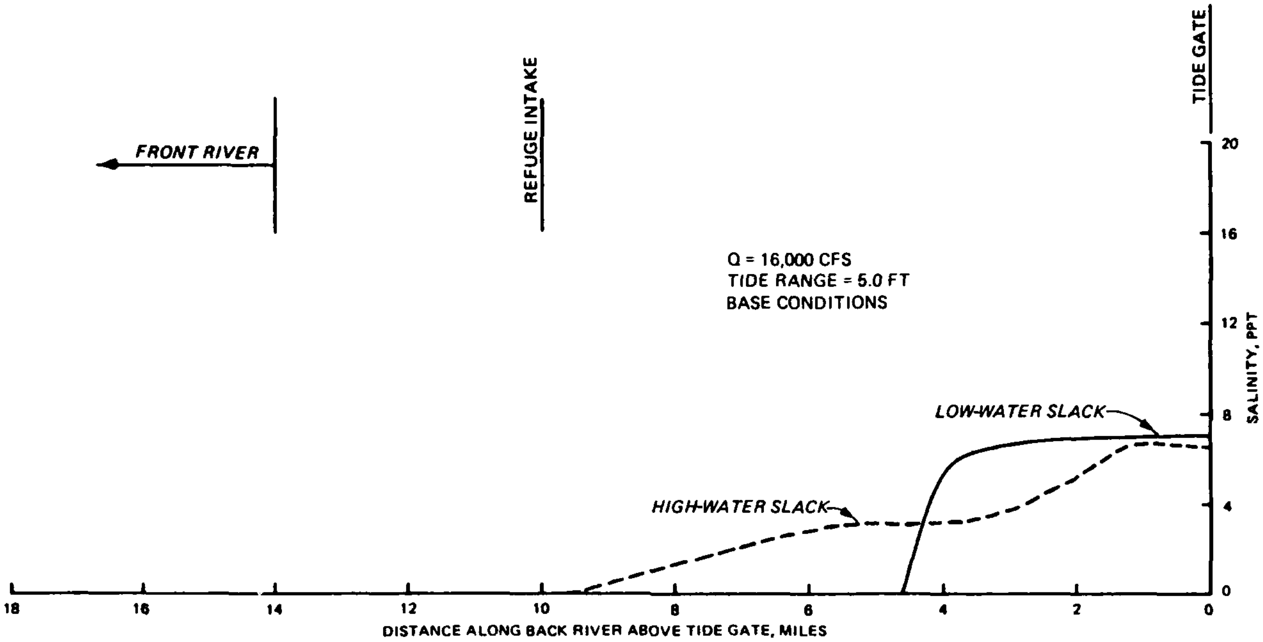


Figure 107. Comparison of high- and low-water slack salinity profiles upstream of the tide gate, 16,000-cfs discharge, 5-ft tide range, base conditions

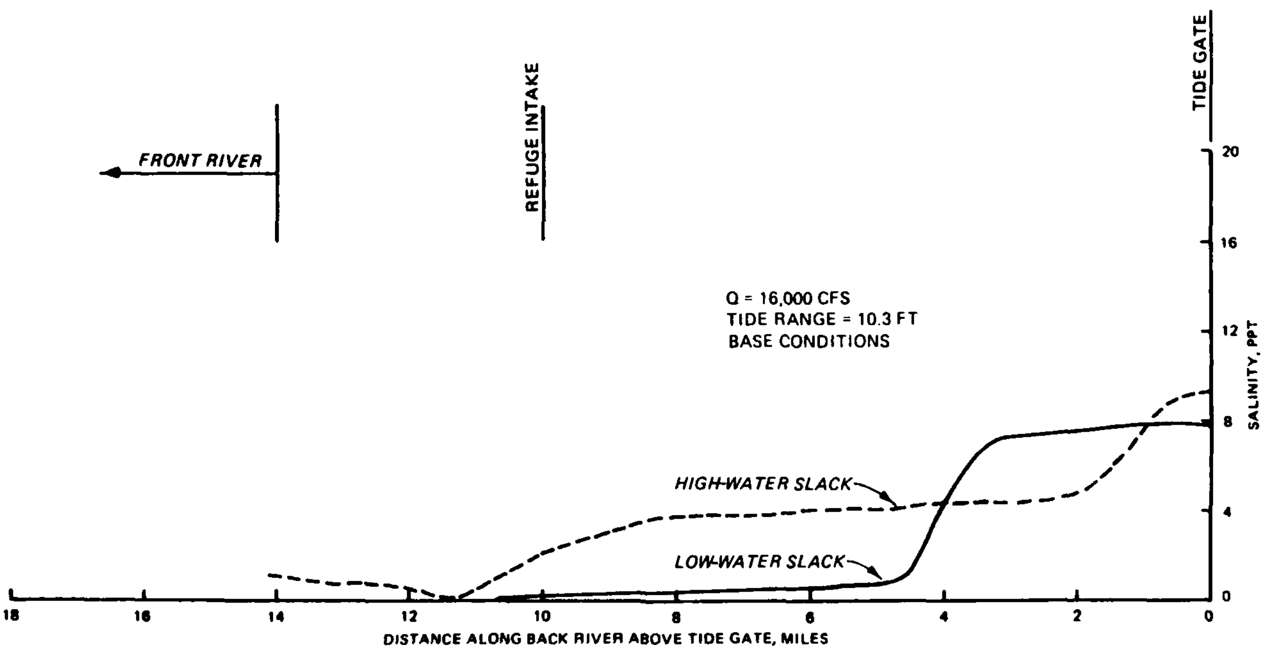


Figure 108. Comparison of high- and low-water slack salinity profiles upstream of the tide gate, 16,000-cfs discharge, 10.3-ft tide range, base conditions

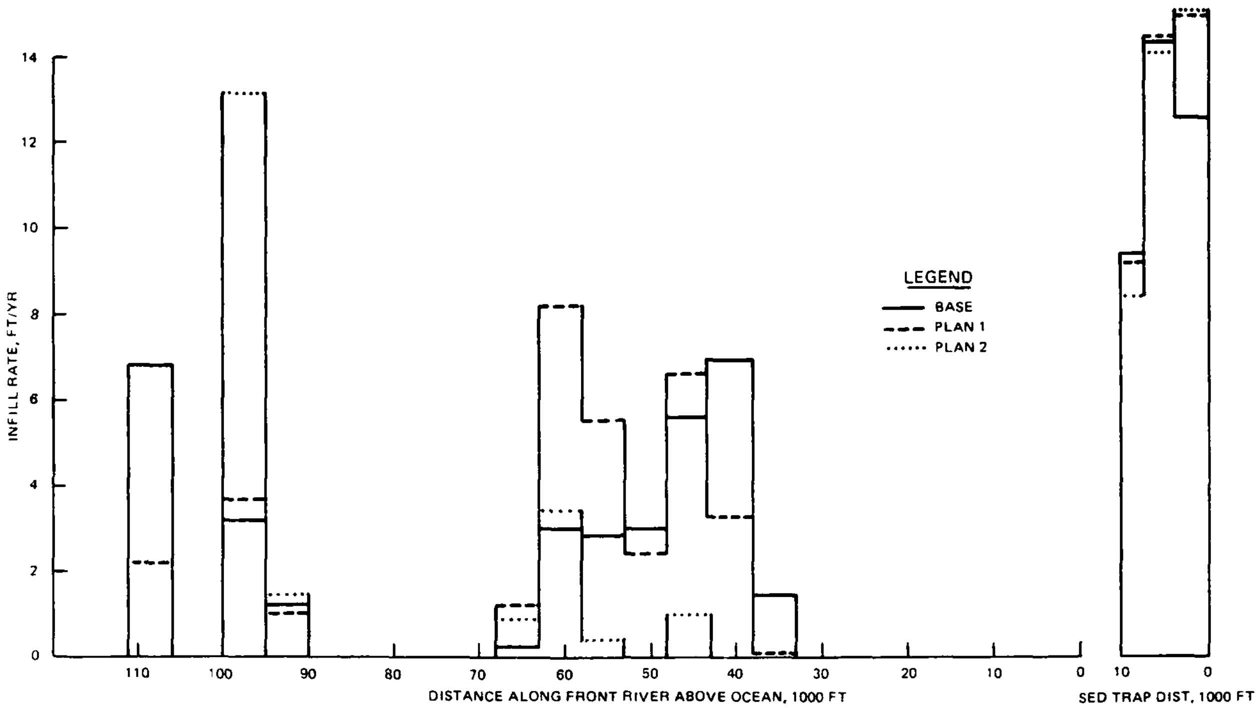


Figure 109. Shoaling in the navigation channel as a result of channel deepening

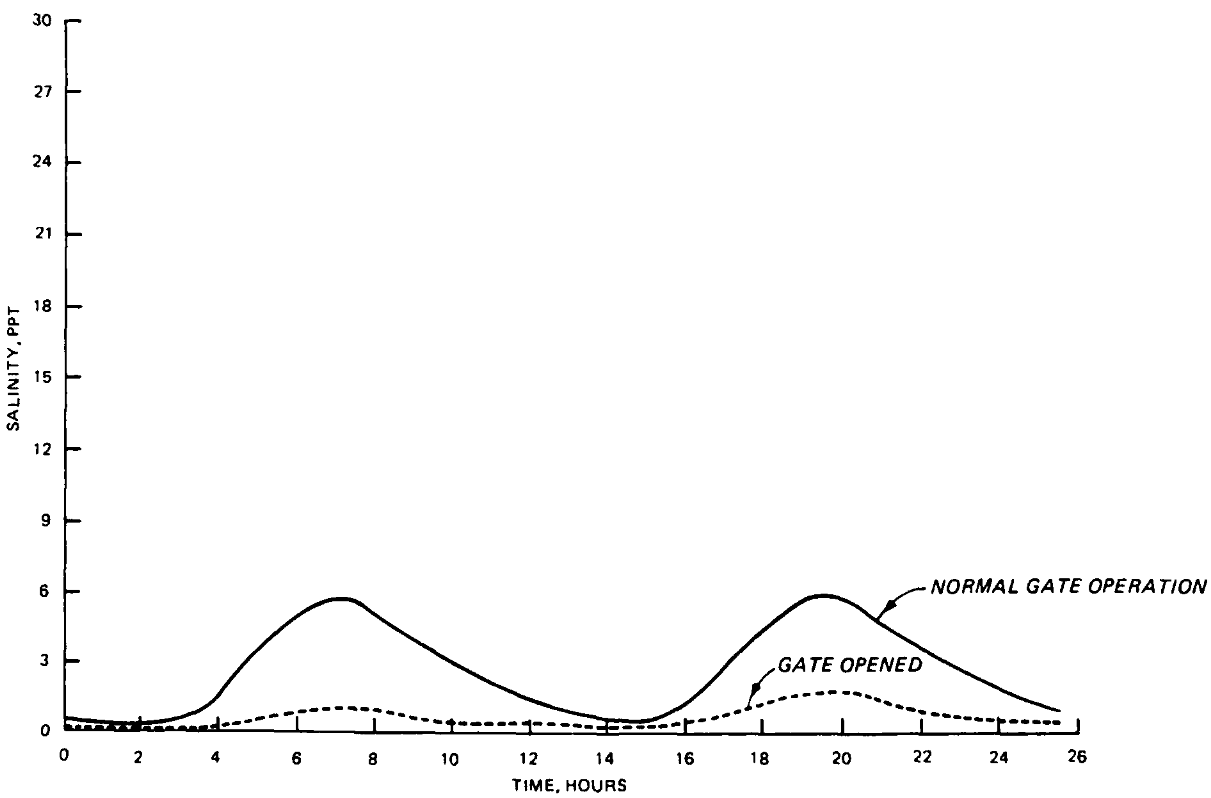


Figure 110. Influence of tide gate on salinity at the Savannah National Wildlife Refuge

APPENDIX A: TIDE GAGE DATA

Plots of tidal elevations at various locations shown in Figure 1 (main text) are presented in Figures A1-A9. The tabulated values, at an interval of 30 min, are presented in Tables A1-A9. Only tidal ranges can be determined from these data since a datum for each gage was not provided.

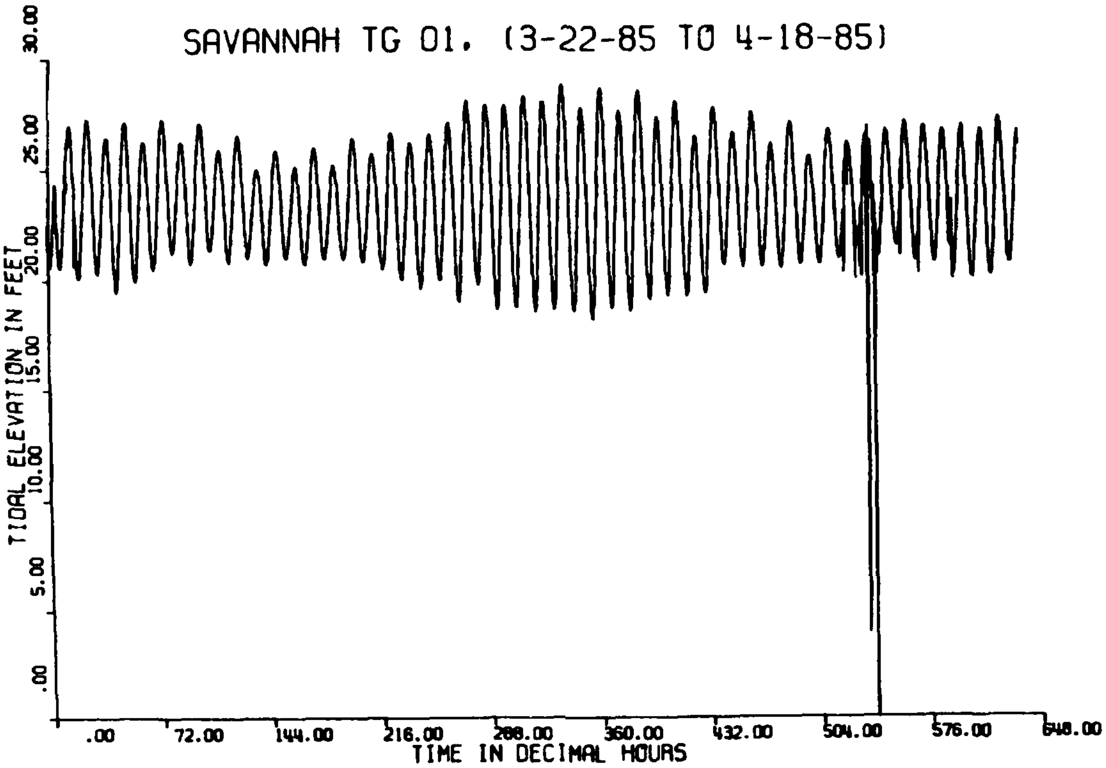


Figure A1. Tidal elevations at Gage 1

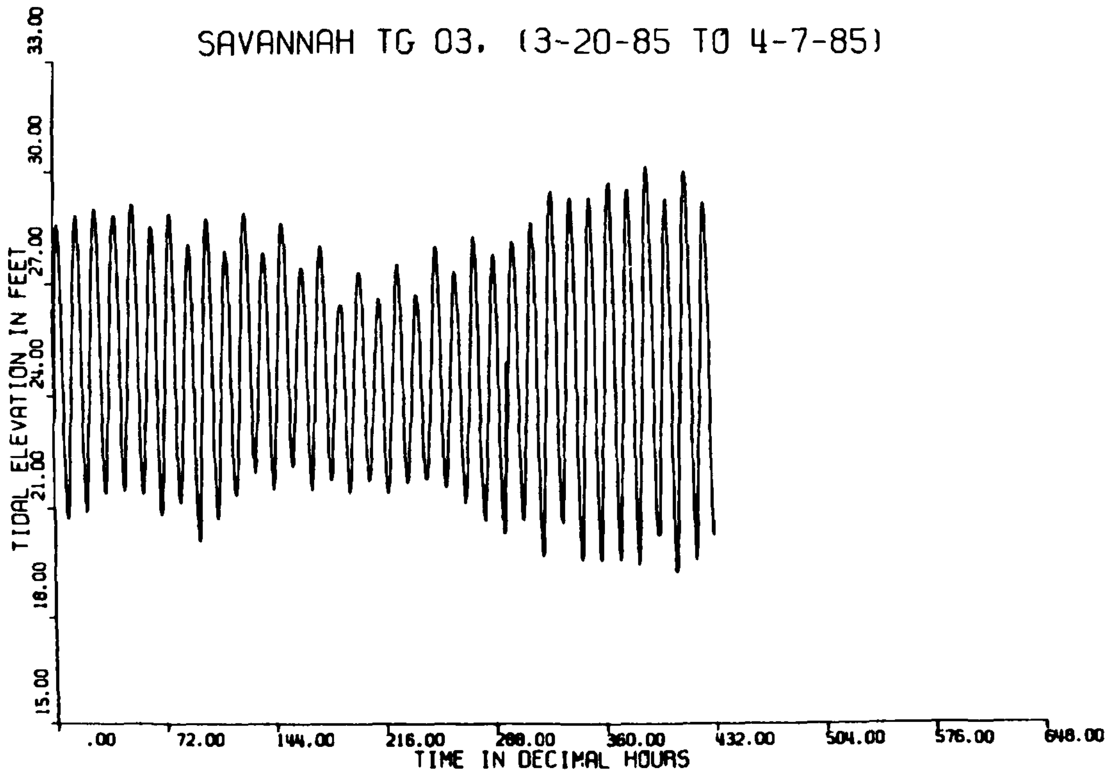


Figure A2. Tidal elevations at Gage 3

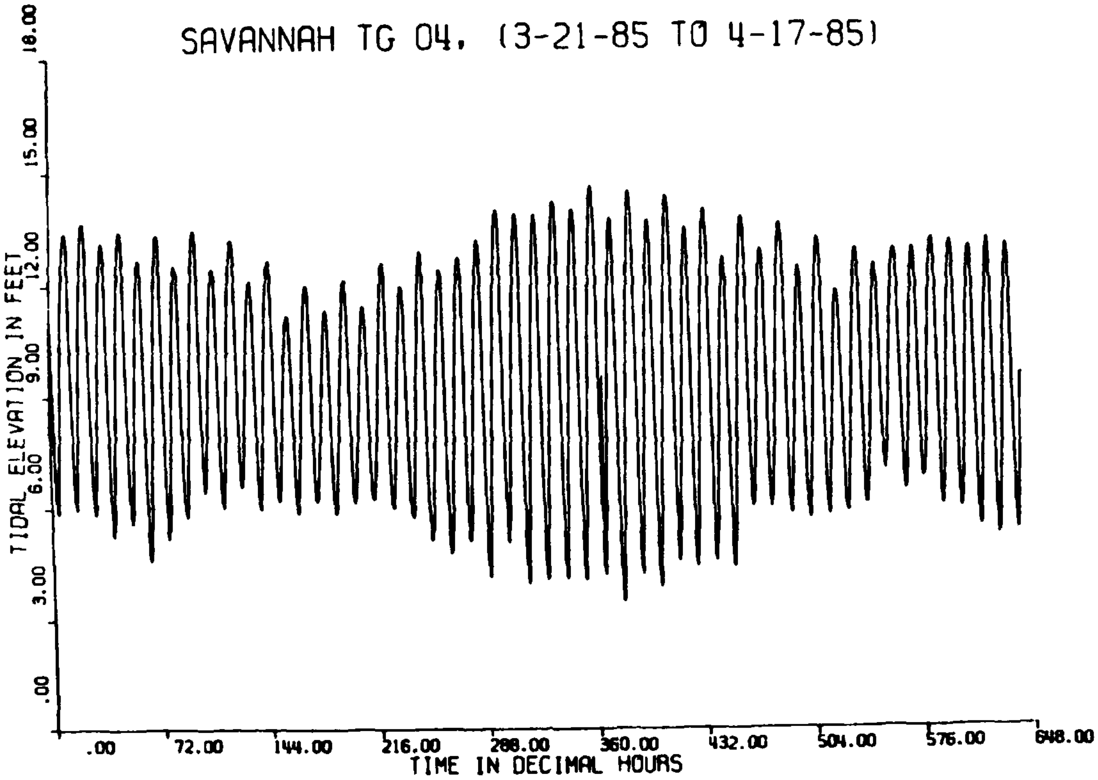


Figure A3. Tidal elevations at Gage 4

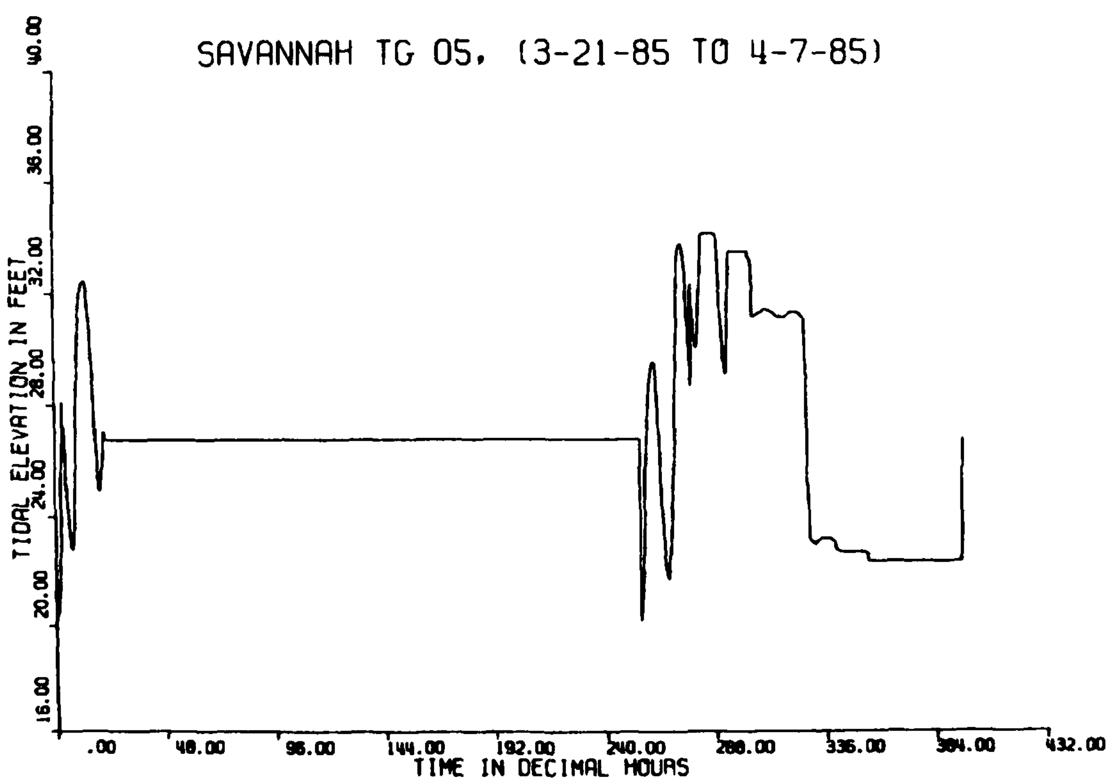


Figure A4. Tidal elevations at Gage 5

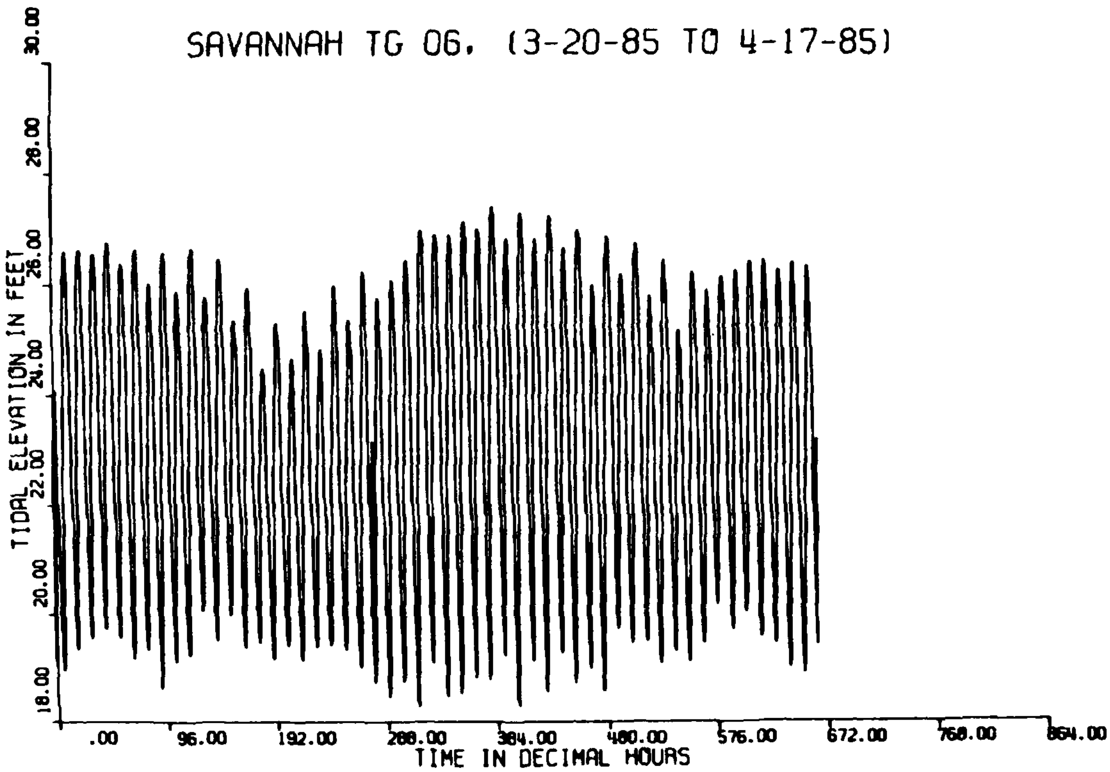


Figure A5. Tidal elevations at Gage 6

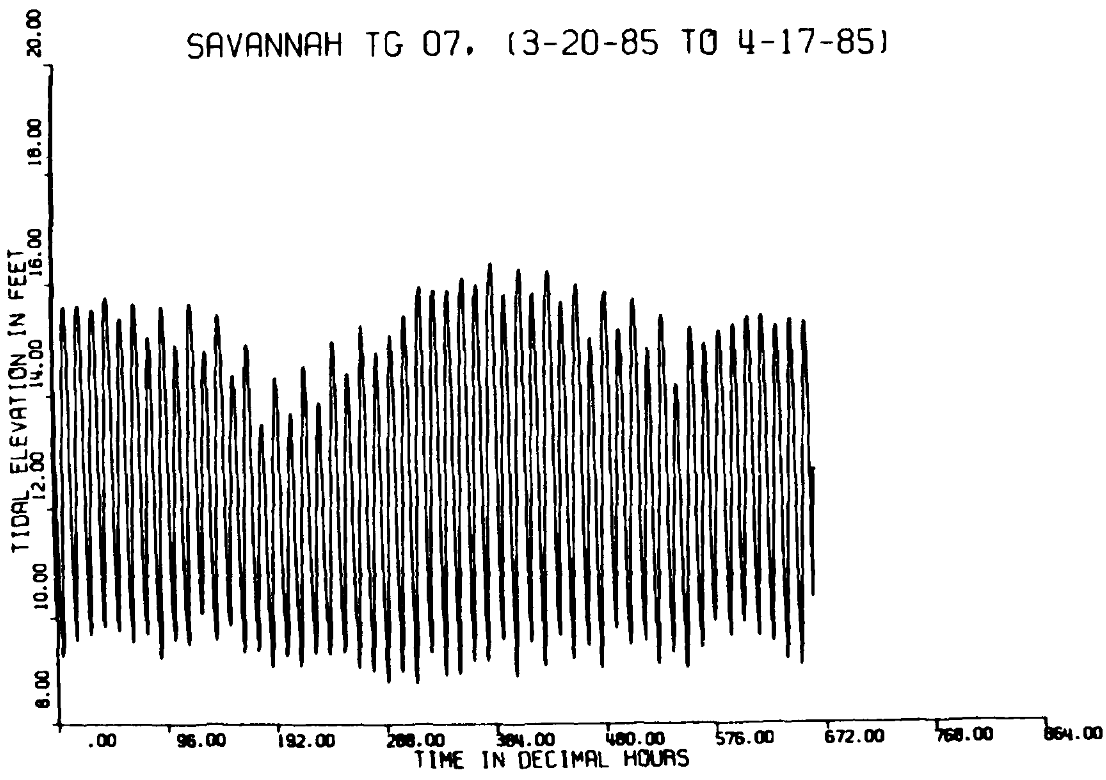


Figure A6. Tidal elevations at Gage 7

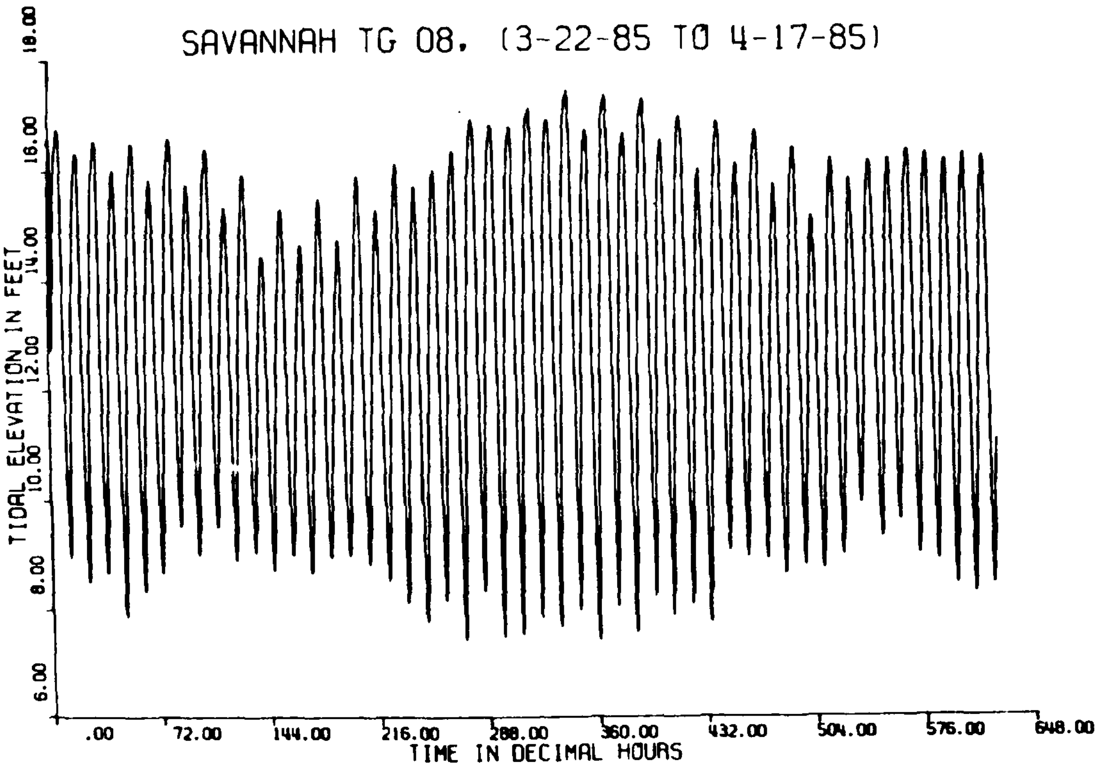


Figure A7. Tidal elevations at Gage 8

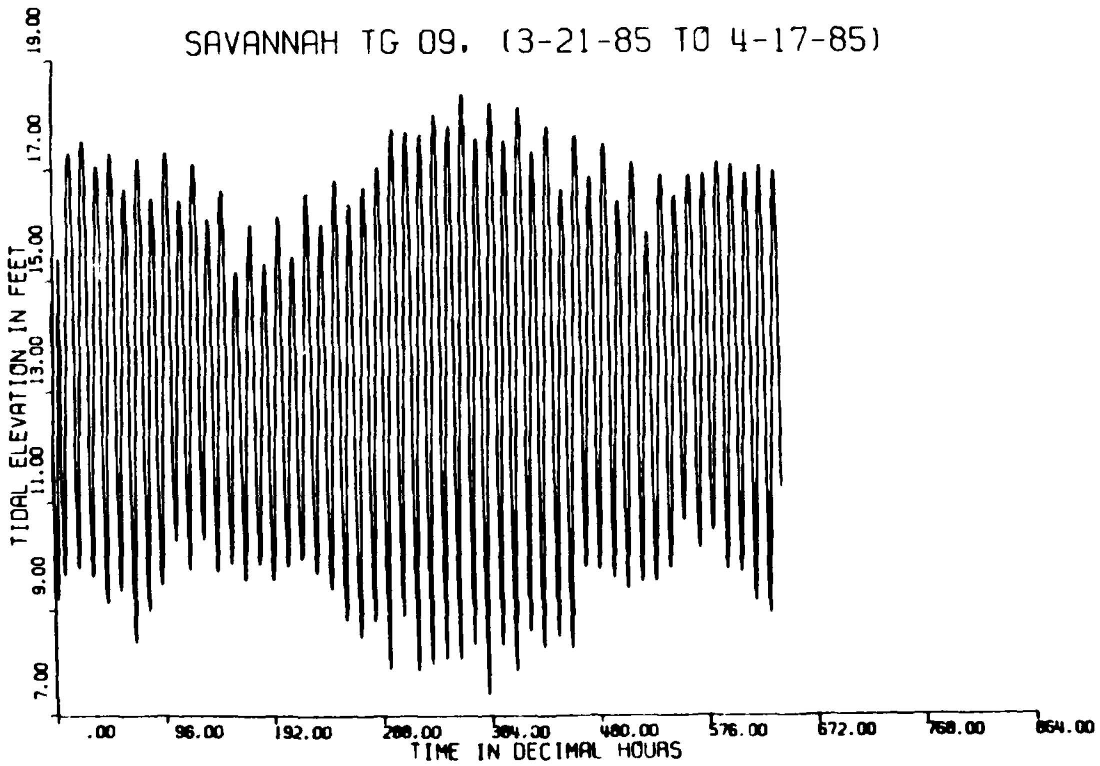


Figure A8. Tidal elevations at Gage 9

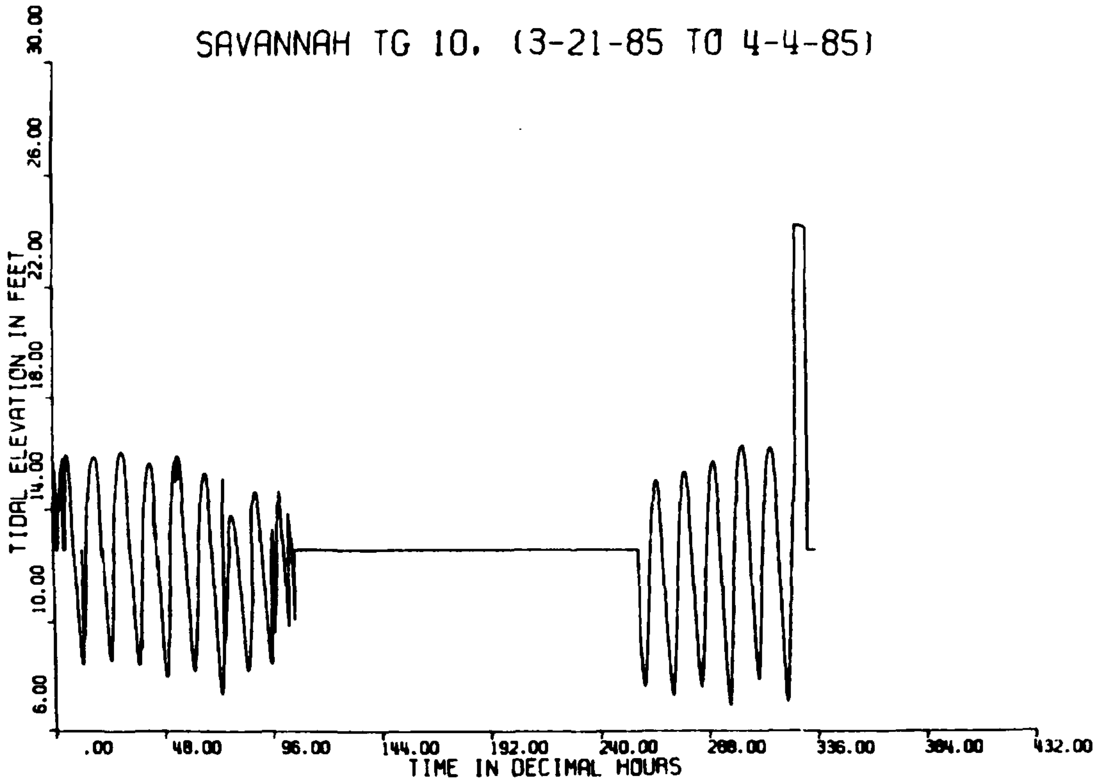


Figure A9. Tidal elevations at Gage 10

Table A1

Tidal Elevations, Tide Gage 1

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-22-85	1300	22.58	21.50	21.23	20.79	20.65	20.81	21.36	22.14	23.02	23.88
3-22-85	1800	24.86	25.68	26.42	26.99	24.38	25.62	24.22	24.04	26.98	26.44
3-22-85	2300	25.83	25.17	24.37	23.58	22.22	22.07	21.40	20.91	20.63	20.60
3-23-85	400	20.81	21.32	21.72	22.74	23.44	24.34	25.13	24.08	26.37	26.03
3-23-85	900	26.91	27.02	26.85	26.42	25.87	25.22	24.53	20.67	22.82	21.92
3-23-85	1400	21.16	20.54	20.17	20.14	20.31	20.84	21.61	22.52	23.45	24.40
3-23-85	1900	25.21	26.05	26.66	27.05	27.32	27.28	27.10	26.66	26.11	25.48
3-24-85	0	24.76	23.99	23.14	22.30	21.58	21.02	20.57	20.36	20.35	20.56
3-24-85	500	21.05	21.75	22.48	23.24	23.88	24.79	25.39	25.90	26.29	26.43
3-24-85	1000	26.42	26.23	25.88	25.35	24.69	23.85	23.06	22.24	21.40	20.60
3-24-85	1500	20.08	19.60	19.50	19.79	20.34	21.13	21.93	22.97	24.06	25.02
3-24-85	2000	25.82	26.42	26.93	27.12	27.12	26.93	26.50	25.90	25.29	24.57
3-25-85	100	23.82	22.98	22.11	21.32	20.68	20.22	19.97	20.07	20.33	20.88
3-25-85	600	21.65	22.45	23.36	24.24	25.01	25.52	25.96	26.20	26.24	26.21
3-25-85	1100	25.95	25.57	25.05	24.38	23.72	23.10	22.28	21.64	21.14	20.76
3-25-85	1600	20.60	20.47	20.67	21.10	21.57	22.49	23.42	24.43	25.13	25.99
3-25-85	2100	26.68	26.96	27.23	27.26	27.13	26.83	26.26	25.73	25.13	24.50
3-26-85	200	23.92	23.22	22.55	21.94	21.57	21.31	21.37	21.49	21.81	22.44
3-26-85	700	22.92	23.73	24.31	24.86	25.30	25.71	26.08	26.21	26.21	26.04
3-26-85	1200	25.71	25.30	24.82	24.24	23.56	22.86	22.19	21.67	21.20	20.91
3-26-85	1700	20.87	20.98	21.41	22.09	22.77	23.62	24.45	25.19	25.88	26.33
3-26-85	2200	26.82	27.03	27.05	26.95	26.68	26.28	25.83	25.22	24.69	24.01
3-27-85	300	23.30	22.63	22.06	21.67	21.41	21.39	21.55	21.86	22.39	22.88
3-27-85	800	23.46	24.01	24.51	24.88	25.30	25.58	25.81	25.88	25.75	25.51
3-27-85	1300	25.21	24.80	24.19	23.54	22.97	22.34	21.73	21.25	21.05	20.93
3-27-85	1800	20.95	21.30	21.83	22.44	23.13	23.84	24.47	25.10	25.60	25.99
3-27-85	2300	26.30	26.47	26.46	26.23	25.88	25.47	24.99	24.39	23.71	23.07
3-28-85	400	22.50	21.99	21.54	21.18	21.02	21.01	21.31	21.67	22.11	22.63
3-28-85	900	23.03	23.50	23.96	24.36	24.69	24.86	24.96	24.95	24.90	24.66
3-28-85	1400	24.27	23.86	23.39	22.80	22.32	21.74	21.25	20.86	20.74	20.73
3-28-85	1900	21.00	21.34	21.74	22.30	22.89	23.44	24.00	24.52	25.03	25.43
3-29-85	0	25.68	25.80	25.80	25.65	25.38	25.03	24.55	23.97	23.35	22.78
3-29-85	500	22.19	21.70	21.38	21.09	20.99	21.04	21.21	21.51	21.82	22.48
3-29-85	1000	22.68	23.14	23.63	24.12	24.48	24.79	25.01	25.10	24.93	24.65
3-29-85	1500	24.26	23.80	23.22	22.53	21.97	21.50	21.15	20.82	20.71	20.68

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 4)

Table A1 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-29-85	2000	20.86	21.20	21.60	22.11	22.65	23.23	23.81	24.46	25.00	25.46
3-30-85	100	25.76	25.92	25.87	25.68	25.35	24.89	24.40	23.82	23.21	22.62
3-30-85	600	22.03	21.56	21.28	20.98	20.94	20.99	21.28	21.64	21.94	22.52
3-30-85	1100	22.94	23.44	23.92	24.38	24.80	25.03	25.16	25.13	24.85	24.67
3-30-85	1600	24.32	23.82	23.31	22.80	22.20	21.81	21.45	21.15	20.98	20.93
3-30-85	2100	21.03	21.25	21.59	22.07	22.63	23.25	23.84	24.53	25.21	25.75
3-31-85	200	26.11	26.33	26.35	26.17	25.85	25.45	24.89	24.20	23.59	22.93
3-31-85	700	22.23	21.72	21.32	20.99	20.81	20.80	21.06	21.41	21.88	22.33
3-31-85	1200	22.92	23.49	24.09	24.63	25.11	25.44	25.63	25.66	25.49	25.25
3-31-85	1700	24.93	24.53	24.02	23.45	22.89	22.20	21.62	21.16	20.86	20.62
3-31-85	2200	20.47	20.54	20.86	21.46	21.97	22.63	23.45	24.29	25.12	25.82
4- 1-85	300	26.32	26.58	26.58	26.44	26.11	25.62	24.94	24.33	23.52	22.77
4- 1-85	800	21.96	21.24	20.69	20.29	20.05	19.99	20.22	20.63	21.34	21.91
4- 1-85	1300	22.63	23.46	24.14	24.81	25.44	25.84	26.09	26.13	25.92	25.68
4- 1-85	1800	25.24	24.62	23.91	23.17	22.49	21.72	21.04	20.48	20.03	19.67
4- 1-85	2300	19.70	19.95	20.26	20.97	21.73	22.79	23.45	24.29	25.08	25.64
4- 2-85	400	26.08	26.38	26.49	26.40	26.12	25.80	25.35	24.66	23.89	23.09
4- 2-85	900	22.28	21.50	20.87	20.39	20.05	19.96	20.14	20.59	21.35	22.11
4- 2-85	1400	22.93	23.84	24.72	25.58	26.20	26.68	26.98	27.01	26.81	26.44
4- 2-85	1900	25.87	25.23	24.46	23.46	22.72	21.75	20.88	20.05	19.46	19.05
4- 3-85	0	18.97	19.31	19.96	20.96	21.98	23.06	24.23	25.30	26.34	27.21
4- 3-85	500	27.67	27.94	28.01	27.78	27.35	26.77	26.01	25.07	24.16	23.28
4- 3-85	1000	22.34	21.52	20.81	20.27	19.93	19.77	19.98	20.55	21.36	22.34
4- 3-85	1500	23.30	24.31	25.27	26.18	26.95	27.51	27.80	27.78	27.60	27.21
4- 3-85	2000	26.65	25.87	25.01	24.05	23.10	22.03	20.96	20.08	19.35	18.87
4- 4-85	100	18.61	18.81	19.38	20.31	21.41	22.50	23.70	24.99	26.04	26.93
4- 4-85	600	27.51	27.78	27.78	27.51	27.01	26.33	25.47	24.53	23.57	22.54
4- 4-85	1100	21.50	20.55	19.74	19.12	18.77	18.70	19.03	19.80	20.81	21.88
4- 4-85	1600	23.06	24.27	25.49	26.53	27.35	27.91	28.16	28.21	28.01	27.52
4- 4-85	2100	26.85	25.97	25.02	24.02	23.00	21.87	20.83	19.86	19.15	18.73
4- 5-85	200	18.58	18.89	19.65	20.73	21.92	23.25	24.43	25.62	26.62	27.40
4- 5-85	700	27.82	27.97	27.89	27.64	27.03	26.20	25.24	24.32	23.37	22.23
4- 5-85	1200	21.20	20.24	19.56	18.83	18.59	18.69	19.30	20.30	21.46	22.70
4- 5-85	1700	23.97	25.34	26.51	27.37	28.08	28.50	28.70	28.65	28.30	27.76
4- 5-85	2200	26.98	25.98	24.94	23.92	22.85	21.78	20.71	19.77	19.10	18.66

(Continued)

Table A1 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 6-85	300	18.53	18.83	19.60	20.66	21.89	23.11	24.30	25.50	26.39	27.05
4- 6-85	800	27.55	27.70	27.53	27.10	26.42	25.51	24.54	23.65	22.71	21.51
4- 6-85	1300	20.43	19.52	18.81	18.36	18.17	18.61	19.33	20.31	21.50	22.61
4- 6-85	1800	23.85	25.16	26.34	27.32	28.02	28.48	28.57	28.41	27.99	27.33
4- 6-85	2300	26.51	25.52	24.43	23.48	22.46	21.40	20.39	19.63	19.01	18.72
4- 7-85	400	18.80	19.43	20.31	21.39	22.51	23.55	24.68	25.72	26.55	27.20
4- 7-85	900	27.51	27.50	27.24	26.74	26.11	25.24	24.35	23.43	22.42	21.39
4- 7-85	1400	20.38	19.56	18.93	18.59	18.63	19.14	19.94	21.02	22.18	23.34
4- 7-85	1900	24.61	25.79	26.82	27.59	28.11	28.38	28.46	28.20	27.79	27.07
4- 8-85	0	26.16	25.21	24.25	23.28	22.17	21.18	20.29	19.60	19.18	19.06
4- 8-85	500	19.38	19.98	20.96	21.86	22.87	23.92	24.98	25.88	26.61	27.08
4- 8-85	1000	27.27	27.21	26.75	26.24	25.53	24.80	23.98	23.09	22.14	21.20
4- 8-85	1500	20.36	19.73	19.31	19.25	19.61	20.21	21.13	22.10	23.05	24.06
4- 8-85	2000	25.13	26.10	26.96	27.40	27.85	27.95	27.78	27.41	26.89	26.20
4- 9-85	100	25.33	24.42	23.56	22.63	21.65	20.74	20.02	19.52	19.34	19.37
4- 9-85	600	19.68	20.44	21.31	22.09	22.98	23.83	24.59	25.19	25.80	26.23
4- 9-85	1100	26.41	26.33	26.16	25.64	25.04	24.26	23.44	22.51	21.56	20.70
4- 9-85	1600	20.05	19.59	19.37	19.55	19.81	20.61	21.46	22.32	23.36	24.30
4- 9-85	2100	25.28	26.04	26.79	27.32	27.59	27.70	27.58	27.21	26.60	25.92
4-10-85	200	25.19	24.34	23.46	22.74	22.08	21.40	20.97	20.71	20.71	20.92
4-10-85	700	21.29	21.93	22.59	23.50	24.03	24.69	25.31	25.79	26.17	26.48
4-10-85	1200	26.58	26.51	26.17	25.72	25.17	24.60	23.89	23.04	22.41	21.72
4-10-85	1700	21.19	20.86	20.72	20.49	21.07	21.51	22.12	22.83	23.59	24.36
4-10-85	2200	25.15	25.82	26.50	27.07	27.34	27.47	27.37	27.09	26.64	25.99
4-11-85	300	25.28	24.44	23.67	22.84	22.05	21.46	20.94	20.61	20.54	20.68
4-11-85	800	21.13	21.68	22.22	22.84	23.42	24.04	24.74	25.30	25.75	25.93
4-11-85	1300	26.07	25.92	25.56	25.08	24.55	23.99	23.29	22.57	21.89	21.41
4-11-85	1800	20.96	20.66	20.49	20.53	20.88	21.40	22.01	22.64	23.41	24.14
4-11-85	2300	24.93	25.61	26.26	26.70	26.91	27.02	26.90	26.63	26.19	25.59
4-12-85	400	24.92	24.25	23.51	22.71	22.03	21.46	20.99	20.66	20.62	20.80
4-12-85	900	21.23	21.74	22.16	22.73	23.28	23.90	24.55	24.95	25.24	25.42
4-12-85	1400	25.48	25.37	25.16	24.78	24.36	23.80	23.23	22.70	22.16	21.58
4-12-85	1900	21.19	20.84	20.67	20.67	20.91	21.33	21.78	22.42	23.10	23.78
4-13-85	0	24.51	25.21	25.83	26.26	26.56	26.70	26.69	26.45	26.10	25.62
4-13-85	500	25.07	24.39	23.06	23.02	22.38	21.74	21.32	21.00	20.95	20.99

(Continued)

(Sheet 3 of 4)

Table A1 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4-13-85	1000	21.22	21.62	22.13	22.34	20.26	23.86	24.62	25.31	25.80	26.00
4-13-85	1500	24.17	26.05	25.82	25.64	25.27	24.82	24.32	23.40	23.09	20.00
4-13-85	2000	22.36	21.92	21.80	21.85	22.07	20.50	22.98	20.47	22.90	24.06
4-14-85	100	25.05	25.64	26.11	26.44	4.00	24.28	26.08	26.00	24.02	26.19
4-14-85	600	24.00	-9.99	24.08	23.08	23.40	20.00	22.24	21.80	21.48	21.27
4-14-85	1100	21.25	21.08	22.14	22.74	23.38	24.07	24.82	25.44	25.96	26.38
4-14-85	1600	26.66	26.66	26.54	26.17	25.85	25.32	24.73	24.12	23.46	22.84
4-14-85	2100	22.30	21.93	21.66	21.61	21.56	21.80	22.17	22.00	21.06	24.07
4-15-85	200	24.78	25.42	26.02	26.48	26.80	27.02	27.07	26.89	26.60	26.16
4-15-85	700	25.24	25.00	24.22	23.20	22.91	22.07	21.56	21.10	20.87	20.88
4-15-85	1200	21.14	21.70	20.24	23.00	23.06	24.55	25.36	25.88	26.37	26.74
4-15-85	1700	26.88	26.83	26.54	26.13	25.68	25.11	24.40	23.07	23.08	22.35
4-15-85	2200	21.75	21.25	20.92	20.73	20.80	21.17	21.81	22.35	23.00	23.74
4-16-85	300	24.49	25.25	26.00	26.23	26.60	26.08	26.63	26.36	25.95	25.39
4-16-85	800	24.72	24.02	23.29	22.49	21.46	-9.99	20.00	20.32	20.24	20.34
4-16-85	1300	20.80	21.47	22.19	22.97	23.91	24.72	25.49	26.07	26.54	26.75
4-16-85	1800	26.87	26.44	25.99	25.62	25.06	24.37	23.51	22.81	22.09	21.35
4-16-85	2300	20.72	20.32	20.07	20.10	20.39	20.84	21.68	22.18	23.01	23.82
4-17-85	400	24.60	25.33	25.99	26.43	26.73	26.70	26.54	26.11	25.62	25.05
4-17-85	900	24.28	23.48	22.61	21.79	21.04	20.50	20.26	20.17	20.34	20.78
4-17-85	1400	21.43	22.18	23.07	24.03	25.00	25.85	26.45	26.92	27.20	27.29
4-17-85	1900	27.14	26.78	26.22	25.76	25.13	24.36	23.57	22.80	22.00	21.47
4-18-85	0	21.04	20.79	20.74	20.93	21.39	22.03	22.56	23.21	23.97	24.67
4-18-85	500	25.39	25.98	26.42	26.68	26.06	26.61	26.32	25.89	-9.99	-9.99

(Sheet 4 of 4)

Table A2

Tidal Elevations, Tide Gage 3

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-20-85	1015	26.36	25.53	24.43	23.46	22.63	21.94	21.37	20.91	20.71	20.89
3-20-85	1515	21.49	22.21	24.25	25.36	26.40	27.31	27.96	28.36	28.56	28.53
3-20-85	2015	28.26	27.96	27.53	26.85	25.97	24.91	23.93	23.09	22.28	21.62
3-21-85	115	21.10	20.82	20.73	21.11	21.79	22.63	23.74	24.81	25.90	26.89
3-21-85	615	27.74	28.31	28.68	28.85	28.73	28.36	28.03	27.63	26.87	26.01
3-21-85	1115	24.96	23.93	22.99	22.18	21.56	21.10	20.93	21.29	22.03	22.82
3-21-85	1615	23.76	24.93	26.05	27.11	27.86	28.33	28.62	28.90	29.00	28.77
3-21-85	2115	28.58	28.02	27.29	26.64	25.87	24.93	24.02	23.25	22.47	21.88
3-22-85	215	21.52	21.42	21.66	22.23	22.97	23.92	24.98	26.02	26.94	27.77
3-22-85	715	28.27	28.61	28.79	28.84	28.77	28.52	28.07	27.54	26.81	26.02
3-22-85	1215	25.00	24.04	23.21	22.45	21.93	21.58	21.53	21.94	22.69	23.61
3-22-85	1715	24.70	25.83	26.90	27.80	28.43	28.88	29.08	29.13	28.95	28.57
3-22-85	2215	28.14	27.57	26.92	26.09	25.13	24.17	23.35	22.60	22.04	21.63
3-23-85	315	21.43	21.50	21.95	22.61	23.56	24.37	25.42	26.39	27.20	27.85
3-23-85	815	28.28	28.48	28.51	28.39	28.08	27.62	26.99	26.18	25.28	24.25
3-23-85	1315	23.36	22.46	21.74	21.17	20.89	21.02	21.42	22.10	23.05	24.22
3-23-85	1815	25.40	26.45	27.41	28.13	28.57	28.83	28.87	28.66	28.31	27.83
3-23-85	2315	27.25	26.49	25.62	24.60	23.71	22.88	22.17	21.68	21.33	21.17
3-24-85	415	21.31	21.75	22.33	23.20	24.13	25.16	26.06	26.80	27.41	27.81
3-24-85	915	28.04	27.98	27.82	27.54	27.05	26.35	25.50	24.50	23.57	22.62
3-24-85	1415	21.77	21.02	20.57	20.17	20.29	20.81	21.59	22.54	23.70	24.95
3-24-85	1915	26.16	27.10	27.93	28.44	28.70	28.73	28.48	28.13	27.67	26.98
3-25-85	15	26.22	25.39	24.42	23.52	22.66	21.91	21.32	20.91	20.74	21.04
3-25-85	515	21.53	22.20	23.14	24.21	25.32	26.08	27.03	27.47	27.82	27.85
3-25-85	1015	27.67	27.57	27.29	26.67	25.94	25.13	24.27	23.54	22.78	22.10
3-25-85	1515	21.68	21.41	21.40	21.49	21.80	22.31	23.19	24.15	25.40	26.36
3-25-85	2015	27.25	28.09	28.57	28.78	28.87	28.68	28.40	27.99	27.46	26.78
3-26-85	115	26.08	25.27	24.46	23.76	23.10	22.56	22.22	21.97	22.18	22.62
3-26-85	615	23.09	23.83	24.61	25.43	26.19	26.77	27.21	27.59	27.80	27.72
3-26-85	1115	27.61	27.37	26.92	26.35	25.74	24.95	24.20	23.50	22.81	22.24
3-26-85	1615	21.96	21.51	21.67	22.14	22.75	23.55	24.42	25.45	26.39	27.19
3-26-85	2115	27.84	28.30	28.55	28.57	28.39	28.24	27.95	27.46	26.87	26.20
3-27-85	215	25.45	24.59	23.87	23.18	22.63	22.26	22.13	22.27	22.65	23.11
3-27-85	715	23.78	24.42	25.09	25.81	26.29	26.75	27.08	27.28	27.39	27.39
3-27-85	1215	27.21	26.91	26.57	26.09	25.39	24.64	23.98	23.36	22.68	22.06

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 3)

Table A2 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-27-85	1715	21.66	21.53	21.78	22.17	22.84	23.62	24.40	25.29	26.08	26.77
3-27-85	2215	27.31	27.70	27.91	27.96	27.89	27.67	27.28	26.78	26.18	25.53
3-28-85	315	24.75	23.99	23.37	22.80	22.32	21.95	21.78	21.82	22.13	22.65
3-28-85	815	23.27	23.89	24.41	24.98	25.54	25.97	26.26	26.36	26.41	26.41
3-28-85	1315	26.33	26.07	25.59	25.01	24.52	23.95	23.35	22.73	22.11	21.66
3-28-85	1815	21.42	21.53	21.80	22.23	22.86	23.55	24.23	24.91	25.57	26.14
3-28-85	2315	26.62	27.01	27.22	27.26	27.21	27.05	26.76	26.30	25.71	25.10
3-29-85	415	24.41	23.72	23.06	22.50	22.06	21.73	21.75	21.86	22.11	22.50
3-29-85	915	22.96	23.59	24.00	24.59	25.10	25.68	26.07	26.36	26.54	26.56
3-29-85	1415	26.35	26.03	25.62	25.05	24.41	23.69	23.00	22.32	21.86	21.54
3-29-85	1915	21.41	21.51	21.75	22.17	22.74	23.35	24.00	24.65	25.35	25.98
3-30-85	15	26.57	27.07	27.39	27.47	27.30	27.04	26.73	26.26	25.47	24.85
3-30-85	515	24.20	23.57	22.91	22.34	21.95	21.72	21.69	21.87	22.18	22.64
3-30-85	1015	23.26	23.70	24.29	24.92	25.49	25.99	26.40	26.65	26.65	26.49
3-30-85	1515	26.27	26.05	25.64	25.01	24.35	23.75	23.18	22.65	22.17	21.91
3-30-85	2015	21.79	21.79	21.92	22.23	22.68	23.25	23.93	24.55	25.32	26.06
3-31-85	115	26.75	27.35	27.76	27.93	27.84	27.59	27.24	26.81	26.17	25.38
3-31-85	615	24.59	23.82	23.07	22.50	22.02	21.70	21.56	21.62	21.91	22.33
3-31-85	1115	22.97	23.60	24.25	24.96	25.64	26.23	26.75	27.11	27.27	27.16
3-31-85	1615	26.93	26.64	26.27	25.80	25.17	24.46	23.83	23.15	22.45	21.91
3-31-85	2115	21.56	21.36	21.23	21.43	21.75	22.39	23.11	23.88	24.71	25.75
4- 1-85	215	26.65	27.43	27.96	28.19	28.09	27.76	27.50	26.99	26.27	25.47
4- 1-85	715	24.57	23.69	22.83	22.03	21.62	21.42	20.96	20.71	20.71	21.25
4- 1-85	1215	21.87	22.64	23.51	24.33	25.22	26.08	26.74	27.30	27.62	27.68
4- 1-85	1715	27.54	27.24	26.89	26.25	25.47	24.59	23.75	22.99	22.23	21.57
4- 1-85	2215	21.00	20.61	20.32	20.45	20.91	-9.99	22.39	23.39	24.40	25.42
4- 2-85	315	26.37	27.11	27.64	27.96	28.05	27.90	27.70	27.40	26.97	26.27
4- 2-85	815	25.37	24.44	23.61	22.78	22.01	21.40	20.93	20.71	20.71	21.16
4- 2-85	1315	21.84	22.73	23.69	24.69	25.77	26.71	27.54	28.09	28.46	28.55
4- 2-85	1815	28.31	28.01	27.63	26.97	26.17	25.27	24.23	23.27	22.34	21.46
4- 2-85	2315	20.69	20.10	19.75	19.78	20.43	21.32	22.47	23.74	25.03	26.29
4- 3-85	415	27.43	28.34	28.94	29.24	29.37	29.33	28.95	28.33	27.70	26.95
4- 3-85	915	26.04	25.01	23.97	23.07	22.24	21.61	21.08	20.73	20.61	21.01
4- 3-85	1415	21.85	22.84	23.96	25.16	26.27	27.27	28.10	28.74	29.10	29.24
4- 3-85	1915	29.16	28.78	28.26	27.64	26.85	25.98	24.86	23.79	22.79	21.89

(Continued)

(Sheet 2 of 3)

Table A2 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 4-85	15	20.99	20.24	19.75	19.60	19.75	20.70	21.80	23.01	24.36	25.69
4- 4-85	515	26.98	27.99	28.73	29.12	29.24	29.13	28.67	28.01	27.30	26.47
4- 4-85	1015	25.51	24.35	23.33	22.38	21.53	20.73	20.08	19.68	19.60	20.15
4- 4-85	1515	21.21	22.35	23.71	25.10	26.41	27.62	28.52	29.14	29.50	29.63
4- 4-85	2015	29.64	29.37	28.64	27.83	27.08	26.18	25.09	23.96	22.91	21.94
4- 5-85	115	21.02	20.28	19.75	19.60	19.92	21.09	22.24	23.65	25.11	26.48
4- 5-85	615	27.68	28.55	29.14	29.42	29.46	29.27	28.84	28.02	27.23	26.36
4- 5-85	1115	25.41	24.29	23.28	22.26	21.38	20.60	19.91	19.49	19.67	20.63
4- 5-85	1615	21.86	23.20	24.64	26.12	27.47	28.54	29.13	29.71	29.97	30.08
4- 5-85	2115	29.98	29.64	28.79	27.92	27.11	26.15	25.04	23.99	22.96	21.97
4- 6-85	215	21.03	20.30	20.29	20.29	20.29	21.07	22.31	23.71	25.10	26.38
4- 6-85	715	27.56	28.33	28.88	29.18	29.18	28.84	28.20	27.41	26.54	25.60
4- 6-85	1215	24.48	23.45	22.40	21.40	20.51	19.79	19.33	19.30	19.41	20.64
4- 6-85	1715	-9.99	23.20	24.57	25.98	27.28	28.32	29.13	29.67	29.89	29.95
4- 6-85	2215	29.81	29.24	28.30	27.53	26.66	25.62	24.48	23.54	22.53	21.59
4- 7-85	315	20.78	20.13	19.67	19.77	20.62	21.90	23.05	24.34	25.64	26.80
4- 7-85	815	27.79	28.51	28.99	29.13	28.99	28.50	27.90	27.22	26.33	25.34

(Sheet 3 of 3)

Table A3

Tidal Elevations, Tide Gage 4

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-21-85	1630	7.90	8.99	10.18	11.39	12.29	12.88	13.17	13.40	13.55	13.47
3-21-85	2130	13.36	13.04	12.49	11.83	11.03	10.11	9.28	8.48	7.67	6.86
3-22-85	230	6.28	5.94	5.91	6.33	7.03	8.02	9.05	10.14	11.29	12.19
3-22-85	730	12.81	13.16	13.34	13.42	13.43	13.31	13.02	12.58	11.99	11.10
3-22-85	1230	10.15	9.28	8.38	7.64	6.90	6.31	6.00	6.11	6.72	7.67
3-22-85	1730	8.79	9.99	11.18	12.21	12.92	13.41	13.61	13.69	13.61	13.40
3-22-85	2230	13.13	12.68	12.00	11.17	10.24	9.41	8.54	7.78	7.02	6.41
3-23-85	330	6.00	5.86	6.12	6.70	7.60	8.55	9.67	10.65	11.60	12.31
3-23-85	830	12.83	13.08	13.15	13.03	12.94	12.62	12.09	11.26	10.31	9.39
3-23-85	1330	8.49	7.65	6.79	6.07	5.54	5.33	5.56	6.20	7.18	8.32
3-23-85	1830	9.54	10.80	11.79	12.64	13.15	13.41	13.44	13.37	13.18	12.83
3-23-85	2330	12.35	11.61	10.69	9.74	8.85	8.05	7.26	6.56	6.04	5.70
3-24-85	430	5.64	5.96	6.49	7.45	8.37	9.45	10.46	11.28	11.93	12.39
3-24-85	930	12.65	12.68	12.58	12.38	12.02	11.33	10.44	9.41	8.49	7.61
3-24-85	1430	6.75	5.96	5.31	4.79	4.64	4.92	5.77	6.76	7.90	9.17
3-24-85	1930	10.48	11.70	12.50	13.04	13.33	13.36	13.22	13.04	12.66	12.07
3-25-85	30	11.26	10.35	9.43	8.54	7.69	6.89	6.19	5.63	5.27	5.30
3-25-85	530	5.77	6.42	7.41	8.46	9.63	10.70	11.59	12.12	12.41	12.52
3-25-85	1030	12.42	12.37	12.13	11.59	10.83	9.95	9.06	8.25	7.54	6.85
3-25-85	1530	6.35	5.97	5.88	5.85	6.08	6.62	7.42	8.37	9.66	10.80
3-25-85	2030	11.78	12.57	13.18	13.39	13.46	13.38	13.23	12.95	12.49	11.85
3-26-85	130	11.03	10.16	9.33	8.58	7.93	7.30	6.86	6.50	6.65	6.93
3-26-85	630	7.45	8.12	8.93	9.84	10.71	11.38	11.85	12.17	12.41	12.44
3-26 85	1130	12.38	12.23	11.83	11.23	10.51	9.74	8.94	8.16	7.47	6.88
3-26-85	1630	6.40	6.02	6.05	6.38	6.88	7.84	8.76	9.82	10.90	11.79
3-26-85	2130	12.45	12.89	13.15	13.20	13.12	13.03	12.77	12.37	11.81	11.08
3-27-85	230	10.24	9.42	8.58	7.86	7.26	6.87	6.62	6.66	6.94	7.44
3-27-85	730	8.12	8.79	9.59	10.32	10.92	11.38	11.70	11.93	12.08	12.08
3-27-85	1230	11.89	11.61	11.21	10.60	9.83	9.02	8.31	7.66	6.99	6.40
3-27-85	1730	6.01	6.00	6.32	6.77	7.56	8.37	9.30	10.21	11.01	11.66
3-27-85	2230	12.12	12.42	12.59	12.64	12.57	12.31	11.92	11.36	10.64	9.88
3-28-85	330	9.05	8.32	7.66	7.10	6.64	6.31	6.19	6.32	6.71	7.35
3-28-85	830	7.97	8.57	9.29	9.83	10.36	10.73	10.99	11.11	11.17	11.15
3-28-85	1330	10.96	10.58	10.07	9.51	8.95	8.30	7.66	7.01	6.45	6.06
3-28-85	1830	5.88	6.01	6.34	6.92	7.58	8.31	9.07	9.79	10.45	10.99

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 4)

Table A3 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-28-85	2330	11.41	11.75	11.91	11.97	11.92	11.74	11.38	10.82	10.14	9.44
3-29-85	430	8.68	7.97	7.33	6.78	6.41	6.22	6.20	6.37	6.73	7.19
3-29-85	930	7.67	8.13	8.79	9.36	9.95	10.44	10.85	11.10	11.27	11.28
3-29-85	1430	11.06	10.72	10.19	9.52	8.70	7.94	7.17	6.61	6.18	5.93
3-29-85	1930	5.88	6.01	6.34	6.85	7.49	8.10	8.77	9.52	10.21	10.82
3-30-85	30	11.40	11.85	12.09	12.11	11.99	11.77	11.36	10.70	9.97	9.21
3-30-85	530	8.43	7.76	7.13	6.62	6.30	6.15	6.19	6.37	6.85	7.35
3-30-85	1030	7.88	8.46	9.11	9.77	10.31	10.81	11.19	11.34	11.39	11.23
3-30-85	1530	11.03	10.62	10.09	9.41	8.69	8.05	7.43	6.91	6.54	6.31
3-30-85	2030	6.25	6.28	6.49	6.88	7.41	8.01	8.71	9.40	10.22	10.96
3-31-85	130	11.65	12.17	12.49	12.57	12.50	12.26	11.94	11.40	10.55	9.69
3-31-85	630	8.85	8.10	7.37	6.77	6.34	6.09	6.01	6.14	6.47	7.09
3-31-85	1130	7.69	8.39	9.13	9.89	10.55	11.15	11.59	11.88	11.93	11.89
3-31-85	1630	11.65	11.33	10.83	10.19	9.46	8.73	8.03	7.36	6.71	6.23
3-31-85	2130	5.93	5.83	5.76	5.97	6.41	7.13	7.91	8.78	9.77	10.61
4- 1-85	230	11.63	12.33	12.75	12.83	12.61	12.52	12.18	11.57	10.71	9.83
4- 1-85	730	8.86	7.92	7.06	6.30	5.73	5.57	5.29	5.14	5.25	5.69
4- 1-85	1230	6.39	7.22	8.09	9.01	9.95	10.77	11.47	11.98	12.27	12.34
4- 1-85	1730	12.26	12.06	11.68	10.99	10.10	9.18	8.26	7.47	6.70	6.02
4- 1-85	2230	5.49	5.06	4.80	4.91	5.38	6.10	7.01	8.01	9.22	10.21
4- 2-85	330	11.20	11.93	12.37	12.64	12.68	12.52	12.42	12.15	11.69	10.90
4- 2-85	830	10.00	9.03	8.11	7.29	6.50	5.89	5.42	5.16	5.15	5.59
4- 2-85	1330	6.33	7.30	8.31	9.41	10.50	11.52	12.26	12.80	13.12	13.13
4- 2-85	1830	12.98	12.77	12.40	11.78	10.90	9.94	8.89	7.92	6.99	6.15
4- 2-85	2330	5.36	4.67	4.23	4.20	4.86	5.80	7.14	8.41	9.83	11.16
4- 3-85	430	12.29	13.15	13.64	13.85	13.92	13.88	13.57	13.15	12.58	11.86
4- 3-85	930	10.94	9.97	8.95	8.04	7.15	6.39	5.75	5.26	5.08	5.45
4- 3-85	1430	6.28	7.44	8.60	9.87	11.07	12.08	12.89	13.47	13.72	13.82
4- 3-85	1930	13.73	13.45	13.08	12.53	11.73	10.78	9.84	8.83	7.84	6.84
4- 4-85	30	5.87	5.04	4.35	3.99	4.20	5.19	6.41	7.75	9.12	10.51
4- 4-85	530	11.79	12.79	13.45	13.73	13.80	13.69	13.30	12.87	12.19	11.31
4- 4-85	1030	10.37	9.39	8.38	7.40	6.40	5.52	4.77	4.24	4.09	4.63
4- 4-85	1530	5.79	7.10	8.46	9.90	11.27	12.42	13.30	13.78	14.03	14.14
4- 4-85	2030	14.13	13.87	13.34	12.72	11.93	11.03	10.10	9.09	8.05	7.00
4- 5-85	130	6.00	5.14	4.43	4.12	4.43	5.63	6.97	8.44	9.95	11.31

(Continued)

(Sheet 2 of 4)

Table A3 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 5-85	630	12.45	13.30	13.76	13.92	13.93	13.82	13.40	12.82	12.09	11.19
4- 5-85	1130	10.29	9.30	8.29	7.28	6.25	5.41	4.62	4.10	4.21	5.24
4- 5-85	1630	6.55	8.04	9.51	11.00	12.30	13.33	13.92	14.21	14.45	14.55
4- 5-85	2130	14.46	14.11	13.50	12.79	11.95	11.07	-9.99	9.20	8.17	7.10
4- 6-85	230	6.12	-9.99	4.58	4.23	4.48	5.73	7.11	8.55	9.93	11.27
4- 6-85	730	12.33	13.10	13.53	13.70	13.68	13.37	12.90	12.23	11.33	10.39
4- 6-85	1230	9.41	8.38	7.30	6.23	5.29	4.46	3.82	3.49	4.04	5.23
4- 6-85	1730	6.60	8.02	9.44	10.88	12.13	13.13	13.82	14.19	14.36	14.41
4- 6-85	2230	14.24	13.71	13.10	12.31	11.42	10.51	9.58	8.61	7.58	6.55
4- 7-85	330	5.74	4.94	4.40	4.35	5.33	6.56	7.96	9.24	10.52	11.69
4- 7-85	830	12.63	13.29	13.61	13.65	13.50	13.10	12.65	11.93	10.97	10.02
4- 7-85	1330	9.02	8.04	7.07	6.07	5.15	4.42	3.95	4.04	4.84	6.17
4- 7-85	1830	7.59	8.96	10.42	11.70	12.75	13.51	13.96	14.17	14.31	14.27
4- 7-85	2330	14.00	13.43	12.77	11.98	11.04	10.16	9.22	8.23	7.23	6.28
4- 8-85	430	5.47	4.85	4.60	5.02	6.07	7.24	8.47	9.68	10.89	11.96
4- 8-85	930	12.75	13.28	13.44	13.41	13.04	12.62	12.08	11.25	10.33	9.39
4- 8-85	1430	8.42	7.49	6.54	5.69	4.97	4.50	4.50	5.19	6.20	7.45
4- 8-85	1930	8.67	9.93	11.17	12.21	13.05	13.52	13.82	13.94	13.88	13.59
4- 9-85	30	13.24	12.72	11.94	10.96	10.05	9.15	8.22	7.27	6.29	5.55
4- 9-85	530	4.97	4.58	4.86	5.63	6.65	7.75	8.78	9.83	10.73	11.44
4- 9-85	1030	12.03	12.47	12.66	12.54	12.39	12.08	11.37	10.41	9.46	8.52
4- 9-85	1530	7.59	6.69	5.85	5.15	4.60	4.43	4.91	5.64	6.75	7.96
4- 9-85	2030	9.15	10.39	11.52	12.40	13.07	13.50	13.70	13.75	13.68	13.45
4-10-85	130	12.99	12.44	11.68	10.72	9.76	8.85	8.10	7.38	6.72	6.14
4-10-85	630	6.01	6.08	6.47	7.20	8.13	9.06	10.09	10.85	11.67	12.25
4-10-85	1130	12.60	12.82	12.83	12.75	12.54	12.15	11.48	10.63	9.75	8.92
4-10-85	1630	8.13	7.40	6.80	6.35	6.06	6.14	6.29	6.82	7.65	8.48
4-10-85	2130	9.48	10.45	11.40	12.16	12.79	13.31	13.52	13.57	13.47	13.28
4-11-85	230	12.92	12.51	11.70	10.74	9.75	8.82	7.98	7.21	6.57	6.12
4-11-85	730	5.85	5.91	6.35	7.06	7.85	8.59	9.49	10.28	11.03	11.66
4-11-85	1230	12.12	12.36	12.37	12.28	11.95	11.44	10.66	9.84	8.94	8.15
4-11-85	1730	7.41	6.80	6.35	6.01	5.76	5.73	6.08	6.72	7.56	8.41
4-11-85	2230	9.40	10.35	11.19	11.98	12.57	12.99	13.15	13.15	13.07	12.89
4-12-85	330	12.50	11.94	11.08	10.20	9.23	8.34	7.54	6.90	6.37	5.98
4-12-85	830	5.79	5.99	6.50	7.24	7.94	8.64	9.41	10.13	10.84	11.38

(Continued)

(Sheet 3 of 4)

Table A3 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4-12-85	1330	11.67	11.77	11.75	11.62	11.38	10.89	10.23	9.56	8.88	8.21
4-12-85	1830	7.61	6.99	6.47	6.10	5.91	5.89	6.16	6.63	7.36	8.14
4-12-85	2330	9.00	9.90	10.71	11.47	12.11	12.58	12.84	12.90	12.69	12.66
4-13-85	430	12.36	11.86	11.16	10.25	9.38	8.57	7.80	7.11	6.53	6.17
4-13-85	930	6.09	6.23	6.55	7.19	7.74	8.49	9.34	10.15	10.91	11.63
4-13-85	1430	12.17	12.41	12.46	12.26	12.12	11.85	11.35	10.65	9.99	9.20
4-13-85	1930	8.55	8.00	7.59	7.26	7.02	7.04	7.35	7.86	8.50	9.21
4-14-85	30	9.90	10.55	11.21	11.85	12.30	12.65	12.82	12.86	12.86	12.76
4-14-85	530	12.60	12.23	11.75	11.03	10.27	9.55	8.81	8.15	7.53	7.00
4-14-85	1030	6.66	6.46	6.46	6.78	7.46	8.25	9.14	10.09	10.98	11.76
4-14-85	1530	12.32	12.69	12.91	12.83	12.60	12.42	12.08	11.42	10.55	9.71
4-14-85	2030	8.94	8.23	7.60	7.17	6.84	6.85	6.84	7.07	7.63	8.30
4-15-85	130	9.13	10.08	10.94	11.74	12.37	12.79	13.03	13.14	13.16	12.98
4-15-85	630	12.74	12.37	11.77	10.97	10.07	9.21	8.39	7.65	6.94	6.39
4-15-85	1130	6.08	6.05	6.41	7.04	7.94	8.83	9.83	10.81	11.71	12.36
4-15-85	1630	12.74	13.04	13.09	12.98	12.75	12.40	11.82	11.12	10.26	9.40
4-15-85	2130	8.57	7.82	7.18	6.64	6.22	5.99	6.04	6.41	7.19	8.05
4-16-85	230	8.93	9.90	10.77	11.63	12.20	12.65	12.89	12.93	12.84	12.59
4-16-85	730	12.26	11.62	10.73	9.82	8.89	8.05	7.26	6.56	6.07	5.69
4-16-85	1230	5.48	5.55	6.09	6.94	7.89	8.90	10.04	11.09	11.91	12.68
4-16-85	1730	12.96	13.05	13.11	12.64	12.21	11.89	11.19	10.21	9.25	8.35
4-16-85	2230	7.58	6.87	6.16	5.59	5.27	5.33	5.69	6.27	7.25	8.03
4-17-85	330	9.07	10.11	11.04	11.84	12.45	12.85	13.00	12.89	12.72	12.39
4-17-85	830	11.88	11.12	10.12	9.16	8.20	7.38	6.56	5.93	5.49	5.37

(Sheet 4 of 4)

Table A4

Tidal Elevations, Tide Gage 5

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-21-85	1415	21.36	20.75	20.43	20.72	21.55	22.61	25.25	26.87	28.12	29.15
3-21-85	1915	29.80	30.15	30.34	30.52	30.54	30.48	30.33	29.95	29.32	28.58
3-22-85	15	27.26	26.83	25.95	25.14	24.34	23.61	23.10	22.88	23.01	23.68
3-22-85	515	24.64	27.25	28.91	30.03	30.97	31.67	32.10	32.31	32.41	32.47
3-22-85	1015	32.44	32.29	31.97	31.43	30.71	29.85	28.93	28.04	27.18	26.36
3-22-85	1515	25.67	25.18	24.99	25.34	26.21	27.04	73.46	73.46	73.46	73.46
3-22-85	2015	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-23-85	115	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-23-85	615	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-23-85	1115	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-23-85	1615	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	-9.99
3-23-85	2115	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-24-85	215	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-24-85	715	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-24-85	1215	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-24-85	1715	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-24-85	2215	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46	73.46
3-25-85	315	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45
3-25-85	815	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45
3-25-85	1315	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45
3-25-85	1815	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45
3-25-85	2315	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45
3-26-85	415	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45	73.45
3-26-85	915	73.45	73.45	73.45	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-26-85	1415	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-26-85	1915	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	15	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	515	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	1015	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	1515	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	2015	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	115	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	615	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	1115	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	1615	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 3)

Table A4 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-28-85	2115	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	215	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	715	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	1215	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	1715	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	2215	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	315	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	815	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	1315	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	1815	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	2315	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	415	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	915	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	1415	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	1915	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
4- 1-85	15	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
4- 1-85	515	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
4- 1-85	1015	-9.99	-9.99	-9.99	20.28	20.79	21.58	22.46	25.42	26.37	27.30
4- 1-85	1515	28.09	28.78	29.23	29.48	29.54	29.50	29.27	28.79	28.03	27.14
4- 1-85	2015	26.23	25.34	24.50	23.74	23.05	22.47	22.03	21.78	21.91	22.45
4- 2-85	115	23.32	24.26	25.36	26.49	29.59	30.50	33.12	33.50	33.69	33.74
4- 2-85	615	33.69	33.52	33.20	32.73	31.93	30.97	30.03	29.13	32.29	31.53
4- 2-85	1115	30.91	30.40	30.11	30.15	30.62	31.51	32.53	33.55	34.10	34.11
4- 2-85	1615	34.12	34.12	34.12	34.12	34.12	34.12	34.12	34.12	34.11	34.10
4- 2-85	2115	34.10	33.84	33.00	32.12	31.25	30.39	29.68	29.21	29.21	29.96
4- 3-85	215	31.15	32.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49
4- 3-85	715	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.28
4- 3-85	1215	33.22	33.05	31.22	31.16	31.18	31.19	31.21	31.25	31.28	31.29
4- 3-85	1715	31.31	31.35	31.40	31.41	31.41	31.41	31.39	31.37	31.35	31.34
4- 3-85	2215	31.30	31.29	31.24	31.19	31.17	31.13	31.18	31.14	31.14	31.13
4- 4-85	315	31.13	31.15	31.20	31.22	31.27	31.30	31.32	31.32	31.32	31.32
4- 4-85	815	31.32	31.32	31.30	31.27	31.26	31.15	31.12	29.21	29.06	25.20
4- 4-85	1315	24.99	23.21	23.15	23.10	23.10	23.04	23.10	23.15	23.15	23.21
4- 4-85	1815	23.22	23.24	23.24	23.24	23.24	23.24	23.24	23.24	23.24	23.24
4- 4-85	2315	23.20	23.15	23.12	23.01	22.83	22.80	22.79	22.77	22.76	22.75

(Continued)

(Sheet 2 of 3)

Table A4 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 5-85	415	22.75	22.75	22.75	22.75	22.75	22.75	22.75	22.75	22.75	22.75
4- 5-85	915	22.75	22.75	22.75	22.75	22.75	22.75	22.75	22.75	22.73	22.72
4- 5-85	1415	22.70	22.69	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 5-85	1915	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 6-85	15	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 6-85	515	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 6-85	1015	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 6-85	1515	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 6-85	2015	22.40	22.40	22.40	22.40	22.40	22.40	22.40	22.40	22.40	22.40
4- 7-85	115	22.40	22.40	22.41	22.41	22.41	22.41	22.41	22.41	22.41	22.41
4- 7-85	615	22.41	22.41	22.41	22.41	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99

(Sheet 3 of 3)

Table A5

Tidal Elevations, Tide Gage 7

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-20-85	1530	19.16	19.06	19.67	20.80	21.95	23.04	24.13	25.06	25.81	26.27
3-20-85	2030	26.46	26.48	26.37	26.19	25.90	25.43	24.81	24.10	23.32	22.57
3-21-85	130	21.83	21.09	20.44	19.84	19.31	19.00	19.10	20.06	21.20	22.39
3-21-85	630	23.49	24.54	25.42	26.08	26.45	26.60	26.62	26.51	26.32	26.05
3-21-85	1130	25.58	24.95	24.26	23.49	22.72	21.96	21.20	20.53	19.93	19.46
3-21-85	1630	19.43	20.25	21.34	22.49	23.62	24.70	25.57	26.15	26.43	26.58
3-21-85	2130	26.65	26.63	26.57	26.36	26.00	25.50	24.89	24.21	23.46	22.73
3-22-85	230	22.00	21.27	20.64	20.09	19.68	19.61	20.30	21.38	22.54	23.63
3-22-85	730	24.64	25.47	26.08	26.39	26.53	26.57	26.57	26.50	26.33	26.02
3-22-85	1230	25.55	24.93	24.27	23.52	22.77	22.05	21.32	20.69	20.14	19.78
3-22-85	1730	19.91	20.94	22.17	23.33	24.47	25.42	26.13	26.53	26.72	26.78
3-22-85	2230	26.76	26.66	26.48	26.19	25.73	25.13	24.48	23.75	22.99	22.27
3-23-85	330	21.54	20.87	20.30	19.83	19.59	19.87	20.92	22.01	23.07	24.09
3-23-85	830	24.96	25.66	26.14	26.35	26.39	26.35	26.21	25.95	25.54	24.94
3-23-85	1330	24.28	23.53	22.79	22.07	21.32	20.65	20.03	19.51	19.21	19.41
3-23-85	1830	20.53	21.70	22.90	24.08	25.08	25.90	26.38	26.61	26.65	26.61
3-23-85	2330	26.48	26.25	25.90	25.37	24.73	24.02	23.25	22.53	21.80	21.09
3-24-85	430	20.49	19.95	19.53	19.37	19.73	20.75	21.83	22.89	23.88	24.72
3-24-85	930	25.36	25.80	26.01	26.01	25.92	25.68	25.31	24.78	24.15	23.40
3-24-85	1430	22.67	21.95	21.22	20.56	19.93	19.33	18.88	18.65	18.94	20.12
3-24-85	1930	21.29	22.53	23.73	24.85	25.73	26.29	26.54	26.60	26.52	26.36
3-25-85	30	26.11	25.69	25.11	24.45	23.72	22.96	22.24	21.51	20.84	20.22
3-25-85	530	19.67	19.26	19.14	19.66	20.74	21.88	22.99	24.06	24.92	25.52
3-25-85	1030	25.83	25.89	25.78	25.61	25.31	24.85	24.30	23.66	22.96	22.30
3-25-85	1530	21.64	20.99	20.45	19.95	19.56	19.30	19.29	19.74	20.69	21.79
3-25-85	2030	22.95	24.08	25.02	25.85	26.38	26.61	26.66	26.63	26.52	26.34
3-26-85	130	26.03	25.55	24.94	24.28	23.56	22.85	22.18	21.52	20.95	20.48
3-26-85	630	20.16	20.09	20.53	21.37	22.33	23.25	24.13	24.81	25.27	25.56
3-26-85	1130	25.74	25.76	25.70	25.50	25.11	24.62	24.05	23.43	22.78	22.14
3-26-85	1630	21.50	20.91	20.39	19.94	19.60	19.56	20.14	21.10	22.13	23.15
3-26-85	2130	24.18	25.05	25.75	26.19	26.41	26.46	26.41	26.31	26.12	25.80
3-27-85	230	25.32	24.73	24.08	23.35	22.66	21.99	21.33	20.78	20.34	20.05
3-27-85	730	20.03	20.50	21.30	22.19	23.01	23.76	24.39	24.83	25.11	25.25
3-27-85	1230	25.35	25.33	25.14	24.83	24.41	23.94	23.34	22.72	22.11	21.48
3-27-85	1730	20.90	20.36	19.88	19.51	19.41	19.83	20.76	21.71	22.66	23.57

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 4)

Table A5 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-27-85	2230	24.40	25.04	25.51	25.80	25.92	25.94	25.85	25.62	25.23	24.73
3-28-85	330	24.15	23.48	22.81	22.17	21.52	20.94	20.44	19.99	19.64	19.50
3-28-85	830	19.73	20.48	21.28	22.08	22.73	23.26	23.80	24.17	24.39	24.48
3-28-85	1330	24.45	24.34	24.13	23.79	23.32	22.84	22.35	21.82	21.24	20.71
3-28-85	1830	20.19	19.72	19.33	19.18	19.37	20.08	20.87	21.72	22.52	23.22
3-28-85	2330	23.89	24.42	24.81	25.11	25.26	25.30	25.21	24.96	24.59	24.10
3-29-85	430	23.53	22.93	22.32	21.69	21.07	20.54	20.07	19.70	19.47	19.44
3-29-85	930	19.77	20.37	20.99	21.62	22.21	22.78	23.32	23.86	24.27	24.51
3-29-85	1430	24.64	24.63	24.41	24.01	23.51	22.94	22.35	21.70	21.05	20.48
3-29-85	1930	19.97	19.53	19.25	19.17	19.40	20.03	20.78	21.52	22.28	22.96
3-30-85	30	23.64	24.28	24.83	25.25	25.48	25.51	25.37	25.07	24.64	24.09
3-30-85	530	23.46	22.82	22.20	21.55	20.94	20.42	19.96	19.61	19.43	19.47
3-30-85	1030	19.91	20.60	21.28	21.95	22.57	23.19	23.78	24.27	24.64	24.81
3-30-85	1530	24.81	24.65	24.34	23.92	23.39	22.85	22.27	21.67	21.08	20.58
3-30-85	2030	20.13	19.77	19.54	19.45	19.56	20.00	20.65	21.37	22.15	22.85
3-31-85	130	23.62	24.36	25.02	25.55	25.88	25.97	25.90	25.67	25.28	24.78
3-31-85	630	24.17	23.46	22.74	22.06	21.37	20.77	20.24	19.80	19.48	19.36
3-31-85	1130	19.58	20.23	21.01	21.84	22.60	23.33	24.04	24.62	25.05	25.29
3-31-85	1630	25.36	25.27	25.03	24.64	24.14	23.59	22.98	22.39	21.77	21.15
3-31-85	2130	20.60	20.08	19.61	19.26	19.05	19.06	19.46	20.32	21.21	22.14
4- 1-85	230	23.05	24.04	24.91	25.63	26.09	26.23	26.15	25.94	25.60	25.08
4- 1-85	730	24.46	23.74	22.96	22.21	21.45	20.76	20.13	19.56	19.10	-9.99
4- 1-85	1230	18.78	19.30	20.28	21.24	22.20	23.08	23.96	24.70	25.27	25.64
4- 1-85	1730	25.76	25.71	25.47	25.10	24.58	23.94	23.21	22.51	21.80	21.10
4- 2-85	330	23.19	24.23	25.04	25.63	25.97	26.07	26.00	25.83	25.54	25.11
4- 2-85	830	24.57	23.90	23.16	22.44	21.71	21.01	20.38	19.79	19.26	18.89
4- 2-85	1330	18.75	19.12	20.22	21.28	22.37	23.42	24.45	25.29	25.93	26.30
4- 2-85	1830	26.43	26.38	26.22	25.95	25.50	24.88	24.18	23.38	22.60	21.83
4- 2-85	2330	21.05	20.35	19.67	19.04	18.56	18.30	18.68	20.00	21.23	22.54
4- 3-85	430	23.80	24.94	25.89	26.47	26.77	26.91	26.95	26.91	26.73	26.43
4- 3-85	930	26.02	25.43	24.74	23.99	23.17	22.39	21.60	20.86	20.20	19.61
4- 3-85	1430	19.19	19.21	20.26	21.47	22.70	23.88	24.92	25.79	26.37	26.69
4- 3-85	1930	26.85	26.89	26.83	26.66	26.35	25.91	25.29	24.62	23.86	23.04
4- 4-85	30	22.24	21.41	20.63	19.91	19.22	18.71	18.49	19.19	20.57	21.84
4- 1-85	2230	20.48	19.87	19.32	18.87	18.55	18.50	18.98	20.03	21.06	22.15

(Continued)

(Sheet 2 of 4)

Table A5 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 4-85	530	23.12	24.40	25.45	26.23	26.64	26.84	26.88	26.78	26.54	26.17
4- 4-85	1030	25.66	25.00	24.29	23.49	22.68	21.87	21.05	20.32	19.62	19.02
4- 4-85	1530	18.60	18.71	19.98	21.25	22.57	23.86	25.01	25.97	26.53	26.85
4- 4-85	2030	27.03	27.11	27.11	26.97	26.68	26.30	25.78	25.15	24.44	23.63
4- 5-85	130	22.79	21.96	21.12	20.37	19.66	19.06	18.84	19.70	21.09	22.47
4- 5-85	630	23.80	24.99	25.95	26.51	26.82	26.96	26.99	26.91	26.66	26.30
4- 5-85	1130	25.80	25.16	24.47	23.70	22.88	22.06	21.23	20.49	19.79	19.16
4- 5-85	1630	18.81	19.32	20.77	22.11	23.45	24.75	25.83	26.51	26.89	27.12
4- 5-85	2130	27.28	27.37	27.37	27.22	26.93	26.58	26.15	25.58	24.90	24.14
4- 6-85	230	23.31	22.50	21.69	20.90	20.21	19.60	19.26	19.80	21.22	22.55
4- 6-85	730	23.83	24.96	25.88	26.42	26.71	26.82	26.77	26.57	26.22	25.72
4- 6-85	1230	25.09	24.40	23.61	22.79	21.98	21.13	20.38	19.65	18.99	18.48
4- 6-85	1730	18.34	19.30	20.69	21.99	23.28	24.57	25.64	26.40	26.82	27.07
4- 6-85	2230	27.22	27.28	27.22	26.98	26.65	26.26	25.72	25.06	24.35	23.54
4- 7-85	330	22.72	21.91	21.09	20.37	19.69	19.20	19.34	20.64	21.91	23.14
4- 7-85	830	24.33	25.33	26.11	26.56	26.77	26.80	26.67	26.42	26.05	25.52
4- 7-85	1330	24.87	24.16	23.35	22.56	21.75	20.97	20.24	19.54	18.94	18.59
4- 7-85	1830	18.87	20.23	21.51	22.84	24.13	25.25	26.14	26.64	26.94	27.10
4- 7-85	2330	27.20	27.22	27.11	26.83	26.49	26.04	25.44	24.77	24.03	23.20
4- 8-85	430	22.41	21.60	20.83	20.14	19.56	19.30	19.89	21.16	22.38	23.55
4- 8-85	930	24.64	25.54	26.21	26.53	26.64	26.58	26.33	25.98	25.48	24.86
4- 8-85	1430	24.16	23.39	22.63	21.85	21.08	20.38	19.71	19.12	18.77	18.90
4- 8-85	1930	20.08	21.30	22.55	23.71	24.82	25.75	26.37	26.71	26.89	26.97
4- 9-85	30	26.95	26.82	26.59	26.24	25.74	25.10	24.41	23.65	22.85	22.06
4- 9-85	530	21.26	20.55	19.89	19.31	19.00	19.28	20.49	21.58	22.64	23.58
4- 9-85	1030	24.44	25.07	25.57	25.91	25.97	25.84	25.58	25.15	24.57	23.89
4- 9-85	1530	23.13	22.42	21.68	20.95	20.29	19.64	19.07	18.68	18.59	19.33
4- 9-85	2030	20.62	21.79	22.95	24.10	25.09	25.90	26.41	26.69	26.82	26.84
4-10-85	130	26.80	26.67	26.39	25.98	25.40	24.75	24.02	23.23	22.50	21.77
4-10-85	630	21.07	20.49	20.02	19.76	19.89	20.77	21.81	22.85	23.79	24.61
4-10-85	1130	25.27	25.77	26.05	26.16	26.15	26.01	25.75	25.31	24.75	24.10
4-10-85	1630	23.38	22.69	22.01	21.33	20.74	20.21	19.78	19.50	19.57	20.28
4-10-85	2130	21.24	22.26	23.20	24.15	24.97	25.68	26.21	26.53	26.69	26.72
4-11-85	230	26.67	26.52	26.28	25.89	25.28	24.62	23.87	23.07	22.32	21.56
4-11-85	730	20.88	20.29	19.80	19.52	19.70	20.57	21.49	22.43	23.21	23.99

(Continued)

(Sheet 3 of 4)

Table A5 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4-11-85	1230	24.64	25.19	25.62	25.79	25.75	25.54	25.14	24.61	23.97	23.26
4-11-85	1730	22.59	21.92	21.23	20.65	20.13	19.66	19.29	19.11	19.31	20.22
4-11-85	2230	21.15	22.14	23.06	23.98	24.79	25.49	26.03	26.33	26.42	26.41
4-12-85	330	26.31	26.11	25.78	25.24	24.59	23.86	23.08	22.33	21.60	20.94
4-12-85	830	20.36	19.84	19.44	19.33	19.82	20.75	21.60	22.41	23.10	23.82
4-12-85	1330	24.48	24.94	25.14	25.15	25.01	24.76	24.38	23.90	23.33	22.78
4-12-85	1830	22.21	21.62	21.05	20.53	20.05	19.61	19.27	19.14	19.29	20.01
4-12-85	2330	20.89	21.79	22.69	23.55	24.37	25.06	25.64	26.03	26.19	26.21
4-13-85	430	26.11	25.90	25.55	25.06	24.47	23.76	23.02	22.33	21.63	20.98
4-13-85	930	20.41	19.92	19.59	19.49	19.77	20.48	21.28	22.18	23.00	23.82
4-13-85	1430	24.57	25.22	25.70	25.88	25.84	25.62	25.33	24.93	24.44	23.86
4-13-85	1930	23.24	22.64	22.04	21.48	21.00	20.62	20.32	20.21	20.45	21.16
4-14-85	30	22.01	22.80	23.51	24.19	24.80	25.32	25.77	26.02	26.13	26.14
4-14-85	530	26.09	25.98	25.75	25.38	24.92	24.34	23.69	23.02	22.39	21.77
4-14-85	1030	21.17	20.66	20.23	19.90	19.74	19.93	20.78	21.77	22.77	23.71
4-14-85	1530	24.59	25.29	25.84	26.14	26.25	26.19	26.01	25.72	25.28	24.72
4-14-85	2030	24.07	23.35	22.67	22.01	21.37	20.85	20.43	20.14	20.06	20.26
4-15-85	130	20.92	21.79	22.73	23.64	24.52	25.24	25.83	26.19	26.35	26.40
4-15-85	630	26.38	26.26	26.04	25.69	25.17	24.56	23.86	23.11	22.41	21.72
4-15-85	1130	21.06	20.48	19.99	19.65	19.64	20.35	21.38	22.43	23.41	24.37
4-15-85	1630	25.17	25.83	26.24	26.40	26.41	26.31	26.11	25.79	25.28	24.68
4-15-85	2130	24.01	23.26	22.57	21.89	21.22	20.65	20.14	19.73	19.48	19.59
4-16-85	230	20.50	21.51	22.51	23.43	24.34	25.07	25.67	26.04	26.22	26.23
4-16-85	730	26.14	25.92	25.55	25.00	24.35	23.62	22.87	22.16	21.44	20.79
4-16-85	1230	20.21	19.69	19.25	19.03	19.23	20.27	21.33	22.42	23.46	24.46
4-16-85	1730	25.30	25.92	26.25	26.35	26.35	26.08	25.71	25.26	24.68	23.98
4-16-85	2230	23.19	22.47	21.75	21.06	20.43	19.84	19.31	18.98	18.94	19.53
4-17-85	330	20.57	21.53	22.57	23.53	24.44	25.20	25.80	26.18	26.31	26.25
4-17-85	830	26.07	25.76	25.26	24.66	23.95	23.17	22.42	21.67	20.95	20.30

(Sheet 4 of 4)

Table A6

Tidal Elevations, Tide Gage 7

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-20-85	1700	19.83	10.83	11.87	12.92	13.91	14.70	15.22	15.43	15.47	15.46
3-20-85	2200	15.29	15.08	14.79	14.33	13.78	13.18	12.57	11.98	11.42	10.87
3-21-85	300	10.39	9.96	9.60	9.33	9.35	10.12	11.20	12.30	13.34	14.27
3-21-85	800	14.99	15.41	15.57	15.61	15.57	15.42	15.22	14.92	14.46	13.92
3-21-85	1300	13.31	12.71	12.08	11.50	10.96	10.47	10.02	9.70	9.60	10.27
3-21-85	1800	11.31	12.39	13.49	14.44	15.09	15.41	15.52	15.60	15.63	15.60
3-21-85	2300	15.49	15.24	14.87	14.41	13.86	13.28	12.68	12.10	11.52	10.99
3-22-85	400	10.52	10.11	9.80	9.71	10.27	11.35	12.42	13.45	14.34	15.00
3-22-85	900	15.36	15.49	15.53	15.55	15.54	15.44	15.22	14.89	14.43	13.90
3-22-85	1400	13.32	12.74	12.13	11.58	11.05	10.59	10.17	9.90	10.00	10.99
3-22-85	1900	12.15	13.26	14.26	15.04	15.49	15.68	15.75	15.77	15.72	15.61
3-23-85	0	15.39	15.08	14.64	14.11	13.54	12.95	12.35	11.79	11.24	10.77
3-23-85	500	10.33	9.99	9.78	10.00	10.93	11.94	12.92	13.83	14.57	15.08
3-23-85	1000	15.33	15.39	15.37	15.30	15.13	14.85	14.44	13.93	13.36	12.77
3-23-85	1500	12.19	11.64	11.12	10.64	10.20	9.85	9.60	9.72	10.62	11.75
3-23-85	2000	12.89	13.95	14.80	15.36	15.59	15.66	15.65	15.58	15.43	15.18
3-24-85	100	14.82	14.34	13.78	13.18	12.60	12.03	11.49	11.01	10.56	10.18
3-24-85	600	9.88	9.72	9.94	10.79	11.79	12.76	13.62	14.31	14.77	15.00
3-24-85	1100	15.07	15.01	14.88	14.65	14.27	13.78	13.25	12.70	12.10	11.58
3-24-85	1600	11.05	10.60	10.17	9.81	9.49	9.28	9.44	10.31	11.38	12.55
3-24-85	2100	13.70	14.65	15.25	15.53	15.61	15.59	15.49	15.30	15.02	14.63
3-25-85	200	14.12	13.56	12.97	12.39	11.84	11.32	10.84	10.41	10.02	9.75
3-25-85	700	9.62	9.94	10.83	11.87	12.91	13.82	14.50	14.83	14.92	14.87
3-25-85	1200	14.76	14.58	14.26	13.85	13.36	12.84	12.30	11.79	11.29	10.85
3-25-85	1700	10.44	10.09	9.81	9.61	9.53	9.87	10.72	11.79	12.93	13.92
3-25-85	2200	14.72	15.34	15.61	15.66	15.66	15.59	15.48	15.26	14.93	14.48
3-26-85	300	13.94	13.38	12.81	12.25	11.72	11.24	10.81	10.45	10.19	10.11
3-26-85	800	10.46	11.26	12.16	13.01	13.74	14.24	14.54	14.72	14.80	14.77
3-26-85	1300	14.66	14.42	14.05	13.61	13.10	12.60	12.09	11.59	11.10	10.67
3-26-85	1800	10.27	9.93	9.68	9.62	10.12	11.04	12.01	13.01	13.93	14.66
3-26-85	2300	15.14	15.37	15.44	15.43	15.35	15.23	15.01	14.67	14.22	13.69
3-27-85	400	13.12	12.54	11.98	11.46	10.98	10.55	10.19	9.95	9.91	10.32
3-27-85	900	11.12	11.93	12.67	13.30	13.79	14.09	14.25	14.34	14.38	14.29
3-27-85	1400	14.06	13.75	13.36	12.94	12.44	11.93	11.42	10.97	10.52	10.11
3-27-85	1900	9.75	9.47	9.38	9.76	10.64	11.54	12.44	13.28	13.97	14.46

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 4)

Table A6 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-28-85	0	14.75	14.88	14.92	14.88	14.76	14.48	14.10	13.63	13.08	12.56
3-28-85	500	12.01	11.49	11.01	10.56	10.17	9.81	9.54	9.40	9.58	10.28
3-28-85	1000	11.02	11.68	12.23	12.72	13.13	13.39	13.48	13.50	13.45	13.30
3-28-85	1500	13.07	12.75	12.36	11.95	11.52	11.10	10.68	10.26	9.87	9.52
3-28-85	2000	9.24	9.11	9.26	9.88	10.64	11.42	12.15	12.79	13.34	13.76
3-29-85	100	14.07	14.25	14.32	14.29	14.13	13.84	13.47	13.03	12.55	12.05
3-29-85	600	11.56	11.06	10.60	10.20	9.84	9.55	9.36	9.31	9.56	10.09
3-29-85	1100	10.65	11.20	11.72	12.26	12.78	13.21	13.49	13.63	13.69	13.58
3-29-85	1600	13.31	12.94	12.51	12.03	11.54	11.06	10.58	10.16	9.78	9.46
3-29-85	2100	9.23	9.13	9.31	9.84	10.52	11.21	11.90	12.55	13.18	13.75
3-30-85	200	14.20	14.48	14.54	14.47	14.27	13.95	13.51	13.04	12.52	12.01
3-30-85	700	11.49	11.00	10.56	10.16	9.82	9.55	9.38	9.39	9.75	10.35
3-30-85	1200	10.95	11.51	12.13	12.71	13.20	13.60	13.85	13.88	13.80	13.59
3-30-85	1700	13.25	12.88	12.44	11.98	11.51	11.05	10.62	10.23	9.90	9.61
3-30-85	2200	9.42	9.33	9.41	9.78	10.39	11.08	11.78	12.50	13.24	13.94
3-31-85	300	14.50	14.85	14.97	14.92	14.78	14.52	14.13	13.66	13.10	12.54
3-31-85	800	11.98	11.44	10.94	10.50	10.09	9.76	9.51	9.38	9.51	10.10
3-31-85	1300	10.83	11.56	12.27	12.95	13.56	14.02	14.29	14.40	14.36	14.21
3-31-85	1800	13.93	13.55	13.09	12.62	12.13	11.65	11.17	10.73	10.30	9.92
3-31-85	2300	9.60	9.32	9.14	9.09	9.45	10.22	11.06	11.94	12.88	13.79
4- 1-85	400	14.56	15.06	15.25	15.19	15.02	14.80	14.43	13.93	13.36	12.78
4- 1-85	900	12.17	11.60	11.04	10.53	10.09	9.69	9.36	9.10	9.03	9.38
4- 1-85	1400	10.19	11.07	11.94	12.78	13.56	14.18	14.60	14.77	14.75	14.62
4- 1-85	1900	14.38	14.00	13.50	12.96	12.39	11.83	11.30	10.78	10.33	9.89
4- 2-85	0	9.52	9.18	8.93	8.81	9.14	10.00	10.98	12.01	13.02	13.91
4- 2-85	500	14.56	14.93	15.05	15.03	14.91	14.73	14.42	14.01	13.50	12.94
4- 2-85	1000	12.36	11.79	11.25	10.73	10.25	9.84	9.47	9.16	9.01	9.27
4- 2-85	1500	10.20	11.19	12.22	13.24	14.16	14.84	15.25	15.41	15.39	15.28
4- 2-85	2000	15.10	14.80	14.35	13.80	13.18	12.57	11.94	11.36	10.80	10.28
4- 3-85	100	9.82	9.39	9.03	8.79	9.02	10.10	11.27	12.52	13.70	14.70
4- 3-85	600	15.40	15.74	15.86	15.91	15.91	15.83	15.63	15.30	14.88	14.33
4- 3-85	1100	13.73	13.08	12.46	11.83	11.23	10.70	10.19	9.77	9.43	9.41
4- 3-85	1600	10.31	11.48	12.65	13.72	14.63	15.28	15.65	15.80	15.86	15.85
4- 3-85	2100	15.75	15.54	15.21	14.76	14.21	13.61	12.97	12.34	11.70	11.08
4- 4-85	200	10.52	10.00	9.54	9.15	8.94	9.47	10.64	11.88	13.11	14.23

(Continued)

(Sheet 2 of 4)

Table A6 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 4-85	700	15.09	15.60	15.80	15.86	15.82	15.67	15.39	15.00	14.51	13.94
4- 4-85	1200	13.31	12.68	12.02	11.40	10.83	10.28	9.80	9.36	9.03	9.06
4- 4-85	1700	10.10	11.33	12.59	13.76	14.77	15.46	15.81	15.97	16.05	16.08
4- 4-85	2200	16.04	15.87	15.57	15.17	14.67	14.09	13.46	12.81	12.14	11.49
4- 5-85	300	10.89	10.34	9.86	9.42	9.21	9.90	11.23	12.52	13.74	14.76
4- 5-85	800	15.45	15.79	15.92	15.96	15.94	15.81	15.54	15.15	14.67	14.11
4- 5-85	1300	13.50	12.86	12.21	11.57	10.98	10.43	9.93	9.50	9.21	9.62
4- 5-85	1800	10.91	12.19	13.46	14.59	15.41	15.85	16.06	16.19	16.29	16.34
4- 5-85	2300	16.30	16.13	15.88	15.54	15.08	14.54	13.94	13.30	12.66	12.01
4- 6-85	400	11.39	10.84	10.33	9.89	9.62	10.05	11.36	12.59	13.75	14.73
4- 6-85	900	15.36	15.66	15.78	15.79	15.68	15.44	15.07	14.60	14.03	13.43
4- 6-85	1400	12.80	12.15	11.53	10.94	10.38	9.89	9.44	9.07	8.92	9.61
4- 6-85	1900	10.82	12.05	13.31	14.45	15.30	15.78	16.01	16.14	16.22	16.24
4- 7-85	0	16.13	15.90	15.59	15.18	14.67	14.09	13.46	12.82	12.16	11.54
4- 7-85	500	10.98	10.45	9.99	9.64	9.70	10.77	11.96	13.11	14.16	15.00
4- 7-85	1000	15.52	15.75	15.80	15.76	15.58	15.30	14.92	14.42	13.85	13.24
4- 7-85	1500	12.61	11.99	11.39	10.83	10.31	9.84	9.43	9.14	9.32	10.40
4- 7-85	2000	11.63	12.89	14.06	15.00	15.59	15.88	16.03	16.14	16.19	16.17
4- 8-85	100	16.02	15.76	15.41	14.96	14.42	13.82	13.19	12.58	11.94	11.35
4- 8-85	600	10.80	10.31	9.91	9.68	10.12	11.24	12.37	13.46	14.42	15.13
4- 8-85	1100	15.52	15.63	15.63	15.48	15.20	14.86	14.38	13.83	13.24	12.64
4- 8-85	1600	12.05	11.46	10.93	10.42	9.98	9.59	9.30	9.34	10.26	11.39
4- 8-85	2100	12.53	13.64	14.61	15.31	15.66	15.83	15.93	15.96	15.91	15.77
4- 9-85	200	15.51	15.14	14.66	14.09	13.50	12.89	12.27	11.67	11.11	10.60
4- 9-85	700	10.14	9.77	9.52	9.67	10.56	11.52	12.47	13.32	14.00	14.49
4- 9-85	1200	14.86	15.00	14.92	14.76	14.49	14.05	13.54	12.97	12.39	11.83
4- 9-85	1700	11.29	10.77	10.29	9.87	9.49	9.18	9.07	9.64	10.70	11.80
4- 9-85	2200	12.92	13.95	14.78	15.34	15.64	15.77	15.81	15.82	15.76	15.58
4-10-85	300	15.25	14.84	14.32	13.73	13.13	12.52	11.95	11.38	10.88	10.43
4-10-85	800	10.07	9.84	9.93	10.73	11.73	12.66	13.49	14.19	14.71	15.00
4-10-85	1300	15.13	15.15	15.08	14.90	14.61	14.18	13.67	13.12	12.55	12.00
4-10-85	1800	11.47	10.97	10.52	10.11	9.79	9.56	9.57	10.21	11.15	12.08
4-10-85	2300	12.99	13.85	14.58	15.12	15.47	15.64	15.68	15.68	15.59	15.41
4-11-85	400	15.12	14.71	14.15	13.56	12.94	12.33	11.72	11.17	10.66	10.20
4-11-85	900	9.84	9.60	9.72	10.46	11.31	12.12	12.86	13.54	14.11	14.59

(Continued)

(Sheet 3 of 4)

Table A6 (Concluded)

DATE	TIME OF FIRST READING EST					ELEVATION FT					
4-11-85	1400	14.80	14.79	14.66	14.39	13.99	13.49	12.95	12.38	11.83	11.30
4-11-85	1900	10.81	10.35	9.95	9.59	9.30	9.13	9.31	10.12	11.02	11.94
4-12-85	0	12.83	13.65	14.38	14.95	15.28	15.39	15.40	15.32	15.19	14.95
4-12-85	500	14.58	14.07	13.47	12.87	12.25	11.67	11.12	10.64	10.17	9.78
4-12-85	1000	9.47	9.35	9.77	10.59	11.33	12.02	12.70	13.38	13.91	14.15
4-12-85	1500	14.18	14.10	13.92	13.63	13.26	12.84	12.38	11.91	11.43	10.98
4-12-85	2000	10.56	10.14	9.77	9.45	9.19	9.06	9.18	9.87	10.70	11.55
4-13-85	100	12.43	13.24	13.96	14.56	14.98	15.16	15.19	15.13	15.00	14.75
4-13-85	600	14.39	13.91	13.36	12.78	12.19	11.64	11.12	10.64	10.20	9.83
4-13-85	1100	9.57	9.45	9.66	10.29	11.09	11.91	12.71	13.45	14.14	14.68
4-13-85	1600	14.89	14.88	14.73	14.51	14.21	13.82	13.37	12.87	12.38	11.88
4-13-85	2100	11.40	10.98	10.61	10.29	10.05	9.96	10.22	10.96	11.75	12.44
4-14-85	200	13.08	13.70	14.26	14.70	14.98	15.10	15.12	15.11	15.03	14.89
4-14-85	700	14.63	14.26	13.81	13.28	12.76	12.22	11.72	11.23	10.81	10.39
4-14-85	1200	10.06	9.80	9.66	9.87	10.71	11.65	12.59	13.47	14.23	14.78
4-14-85	1700	15.10	15.22	15.23	15.10	14.89	14.58	14.15	13.63	13.07	12.51
4-14-85	2200	11.97	11.45	10.99	10.59	10.26	10.02	9.92	10.10	10.75	11.62
4-15-85	300	12.54	13.40	14.18	14.78	15.15	15.31	15.36	15.37	15.32	15.16
4-15-85	800	14.91	14.53	14.05	13.50	12.92	12.34	11.79	11.26	10.78	10.35
4-15-85	1300	9.98	9.73	9.70	10.37	11.37	12.30	13.24	14.10	14.76	15.20
4-15-85	1800	15.38	15.40	15.35	15.22	14.99	14.63	14.15	13.61	13.04	12.47
4-15-85	2300	11.91	11.38	10.89	10.45	10.07	9.76	9.57	9.68	10.49	11.44
4-16-85	400	12.33	13.21	14.00	14.59	15.00	15.17	15.22	15.17	15.03	14.77
4-16-85	900	14.37	13.87	13.30	12.71	12.11	11.56	11.03	10.55	10.12	9.74
4-16-85	1400	9.56	9.23	9.41	10.32	11.32	12.33	13.32	14.21	14.87	15.22
4-16-85	1900	15.32	15.33	15.20	14.91	14.56	14.11	13.57	12.97	12.36	11.78
4-17-85	0	11.24	10.73	10.26	9.84	9.46	9.20	9.11	9.61	10.50	11.45
4-17-85	500	12.42	13.32	14.12	14.74	15.13	15.29	15.27	15.13	14.91	14.57
4-17-85	1000	14.08	13.52	12.93	12.31	11.71	11.14	10.62	-9.99	-9.99	-9.99

(Sheet 4 of 4)

Table A7

Tidal Elevations, Tide Gage 8

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-22-85	930	16.48	16.56	16.56	16.43	16.10	15.17	14.84	13.97	13.07	12.23
3-22-85	1430	11.39	10.60	9.87	9.22	9.45	10.45	11.55	12.76	13.89	14.88
3-22-85	1930	15.60	16.11	16.35	16.49	16.63	16.75	16.74	16.58	16.26	15.77
3-23-85	30	15.07	14.24	13.32	12.47	11.63	10.84	10.10	9.41	8.99	9.43
3-23-85	530	10.38	11.37	12.41	13.44	14.33	14.99	15.49	15.82	16.08	16.28
3-23-85	1030	16.33	16.27	16.05	15.58	14.89	14.04	13.15	12.30	11.46	10.66
3-23-85	1530	9.86	9.10	8.54	8.89	9.87	11.03	12.29	13.42	14.46	15.29
3-23-85	2030	15.82	16.13	16.26	16.46	16.55	16.51	16.33	15.92	15.31	14.52
3-24-85	130	13.63	12.73	11.88	11.07	10.29	9.56	8.94	8.70	9.22	10.10
3-24-85	630	11.06	12.16	13.09	13.96	14.58	15.07	15.42	15.78	16.01	15.98
3-24-85	1130	15.79	15.39	14.81	14.09	13.24	12.41	11.60	10.73	9.98	9.13
3-24-85	1630	8.45	7.90	8.35	9.36	10.52	11.83	13.08	14.24	15.05	15.68
3-24-85	2130	16.01	16.20	16.41	16.50	16.42	16.21	15.76	15.05	14.20	13.30
3-25-85	230	12.45	11.59	10.78	9.99	9.23	8.61	8.38	9.06	10.01	11.10
3-25-85	730	12.28	13.29	14.17	14.74	15.10	15.47	15.78	15.84	15.70	15.44
3-25-85	1230	14.98	14.33	13.58	12.76	11.99	11.23	10.53	9.84	9.24	8.82
3-25-85	1730	8.78	9.27	10.03	10.99	12.27	13.38	14.31	15.17	15.85	16.08
3-25-85	2230	16.28	16.49	16.58	16.54	16.41	16.08	15.55	14.80	13.97	13.10
3-26-85	330	12.32	11.54	10.85	10.23	9.73	9.65	10.16	10.74	11.59	12.50
3-26-85	830	13.30	14.00	14.49	14.88	15.23	15.56	15.74	15.66	15.43	15.07
3-26-85	1330	14.56	13.88	13.14	12.41	11.66	10.92	10.25	9.63	9.15	9.07
3-26-85	1830	9.66	10.47	11.32	12.43	13.45	14.35	15.05	15.53	15.90	16.14
3-26-85	2330	16.34	16.38	16.31	16.17	15.85	15.30	14.62	13.82	13.01	12.23
3-27-85	430	11.46	10.76	10.16	9.66	9.62	10.10	10.72	11.44	12.21	12.91
3-27-85	930	13.50	14.07	14.43	14.81	15.13	15.31	15.34	15.16	14.78	14.34
3-27-85	1430	13.81	13.12	12.41	11.67	10.98	10.35	9.73	9.16	8.94	9.40
3-27-85	1930	10.18	10.97	11.85	12.78	13.59	14.28	14.78	15.16	15.51	15.81
3-28-85	30	15.91	15.87	15.66	15.25	14.70	14.04	13.29	12.55	11.79	11.08
3-28-85	530	10.44	9.87	9.38	9.09	9.34	9.96	10.58	11.26	11.75	12.47
3-28-85	1030	12.99	13.45	13.86	14.23	14.41	14.44	14.33	14.13	13.81	13.32
3-28-85	1530	12.71	12.08	11.49	10.90	10.29	9.66	9.11	8.75	9.03	9.52
3-28-85	2030	10.17	10.92	11.65	12.39	13.08	13.65	14.11	14.51	14.91	15.20
3-29-85	130	15.28	15.19	14.97	14.62	14.14	13.50	12.81	12.10	11.38	10.71
3-29-85	630	10.08	9.50	9.11	9.04	9.38	9.81	10.29	10.80	11.39	11.99
3-29-85	1130	12.58	13.11	13.55	13.95	14.32	14.56	14.63	14.44	14.02	13.45

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 4)

Table A7 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-29-85	1630	12.84	12.15	11.39	10.67	9.96	9.28	8.83	8.71	8.99	9.46
3-29-85	2130	10.05	10.71	11.39	12.11	12.82	13.46	14.07	14.54	14.90	15.28
3-30-85	230	15.47	15.38	15.07	14.66	14.12	13.44	12.68	11.94	11.21	10.54
3-30-85	730	9.91	9.36	9.01	9.07	9.47	9.95	10.53	11.08	11.71	12.38
3-30-85	1230	12.95	13.46	13.88	14.24	14.59	14.72	14.59	14.25	13.82	13.29
3-30-85	1730	12.70	12.03	11.36	10.73	10.14	9.61	9.21	9.02	9.18	9.52
3-30-85	2230	10.00	10.59	11.27	12.01	12.76	13.53	14.24	14.81	15.18	15.52
3-31-85	330	15.81	15.85	15.67	15.28	14.79	14.16	13.35	12.52	11.71	10.95
3-31-85	830	10.24	9.60	9.10	8.85	9.11	9.64	10.28	10.95	11.66	12.41
3-31-85	1330	13.10	13.74	14.23	14.61	14.95	15.22	15.22	14.96	14.56	14.08
3-31-85	1830	13.52	12.88	12.22	11.54	10.85	10.17	9.51	8.98	8.67	8.61
3-31-85	2330	8.97	9.68	10.43	11.25	12.23	13.19	14.14	14.88	15.38	15.66
4- 1-85	430	15.98	16.09	15.95	15.66	15.16	14.46	13.63	12.78	11.95	11.06
4- 1-85	930	10.27	9.49	8.82	8.32	8.17	8.74	9.56	10.45	11.32	12.26
4- 1-85	1430	13.12	13.89	14.44	14.94	15.30	15.64	15.67	15.49	15.12	14.63
4- 1-85	1930	13.94	13.08	12.24	11.39	10.62	9.86	9.14	8.52	8.01	7.83
4- 2-85	30	8.41	9.26	10.26	11.37	12.41	13.43	14.25	14.86	15.26	15.60
4- 2-85	530	15.89	15.97	15.85	15.59	15.18	14.65	13.91	13.03	12.17	11.33
4- 2-85	1030	10.55	9.78	9.07	8.51	8.19	8.63	9.53	10.55	11.60	12.72
4- 2-85	1530	13.74	14.62	15.27	15.72	15.98	16.23	16.31	16.24	16.02	15.59
4- 2-85	2030	14.91	14.03	13.10	12.20	11.29	10.44	9.58	8.77	8.04	7.47
4- 3-85	130	8.02	9.22	10.52	11.87	13.14	14.35	15.33	16.10	16.46	16.65
4- 3-85	630	16.70	16.80	16.88	16.81	16.53	16.07	15.44	14.64	13.66	12.69
4- 3-85	1130	11.76	10.86	10.01	9.21	8.56	8.54	9.50	10.74	11.99	13.16
4- 3-85	1630	14.25	15.14	15.90	16.32	16.52	16.57	16.70	16.78	16.69	16.42
4- 3-85	2130	15.94	15.26	14.42	13.45	12.50	11.53	10.61	9.68	8.80	8.01
4- 4-85	230	7.53	8.42	9.79	11.17	12.55	13.82	14.94	15.79	16.31	16.52
4- 4-85	730	16.56	16.67	16.74	16.61	16.25	15.68	14.93	14.04	13.07	12.11
4- 4-85	1230	11.13	10.20	9.26	8.43	7.70	7.88	9.06	10.49	11.88	13.25
4- 4-85	1730	14.48	15.51	16.23	16.61	16.82	16.91	16.91	17.03	17.03	16.75
4- 4-85	2230	16.30	15.72	14.96	14.06	13.05	12.05	11.05	10.10	9.15	8.33
4- 5-85	330	7.86	8.86	10.37	11.84	13.24	14.53	15.52	16.23	16.55	16.70
4- 5-85	830	16.71	16.81	16.87	16.73	16.31	15.75	14.99	14.11	13.11	12.14
4- 5-85	1330	11.15	10.21	9.26	8.43	7.71	8.45	9.85	11.34	12.83	14.19
4- 5-85	1830	15.35	16.27	16.71	17.00	17.21	17.26	17.24	17.38	17.32	16.96

(Continued)

(Sheet 2 of 4)

Table A7 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4- 5-85	2330	16.53	16.01	15.31	14.46	13.47	12.51	11.45	10.48	9.53	8.67
4- 6-85	430	8.01	8.86	10.39	11.85	13.17	14.42	15.37	16.01	16.39	16.49
4- 6-85	930	16.55	16.67	16.62	16.34	15.80	15.06	14.20	13.22	12.28	11.30
4- 6-85	1430	10.36	9.39	8.53	7.77	7.46	8.40	9.90	11.34	12.72	14.06
4- 6-85	1930	15.16	16.09	16.66	16.98	17.14	17.15	17.21	17.30	17.14	16.72
4- 7-85	30	16.24	15.60	14.79	13.84	12.83	11.83	10.84	9.90	9.00	8.23
4- 7-85	530	8.44	9.70	11.13	12.46	13.67	14.74	15.58	16.15	16.41	16.42
4- 7-85	1030	16.55	16.62	16.48	16.08	15.49	14.70	13.78	12.82	11.88	10.95
4- 7-85	1530	10.03	9.11	8.29	7.59	8.04	9.31	10.78	12.21	13.55	14.74
4- 7-85	2030	15.71	16.36	16.72	16.96	17.07	17.07	17.21	17.24	16.98	16.54
4- 8-85	130	16.03	15.32	14.47	13.48	12.49	11.48	10.54	9.62	8.79	8.26
4- 8-85	630	9.07	10.34	11.57	12.81	13.94	14.89	15.64	16.07	16.21	16.36
4- 8-85	1130	16.49	16.42	16.11	15.54	14.83	13.96	13.06	12.17	11.26	10.41
4- 8-85	1630	9.54	8.74	8.07	8.19	9.23	10.51	11.79	12.99	14.13	15.11
4- 8-85	2130	15.88	16.32	16.61	16.73	16.80	16.91	16.90	16.69	16.30	15.75
4- 9-85	230	14.99	14.09	13.13	12.21	11.28	10.41	9.52	8.73	8.13	8.55
4- 9-85	730	9.65	10.77	11.84	12.81	13.66	14.34	14.87	15.32	15.62	15.92
4- 9-85	1230	15.93	15.67	15.26	14.65	13.82	12.97	12.09	11.22	10.39	9.55
4- 9-85	1730	8.77	8.08	7.78	8.64	9.73	10.97	12.21	13.35	14.40	15.22
4- 9-85	2230	15.89	16.29	16.48	16.60	16.74	16.82	16.77	16.52	16.07	15.45
4-10-85	330	14.66	13.71	12.77	11.88	11.06	10.31	9.61	9.10	9.37	10.16
4-10-85	830	11.02	12.05	12.95	13.79	14.49	15.02	15.41	15.69	15.96	16.09
4-10-85	1330	16.02	15.79	15.33	14.70	13.94	13.10	12.33	11.53	10.79	10.11
4-10-85	1830	9.47	9.14	9.14	9.73	10.52	11.41	12.40	13.33	14.23	14.98
4-10-85	2330	15.60	16.09	16.32	16.47	16.63	16.68	16.62	16.40	16.01	15.39
4-11-85	430	14.56	13.62	12.70	11.80	10.96	10.18	9.47	8.95	9.18	9.92
4-11-85	930	10.65	11.43	12.26	13.10	13.77	14.42	14.93	15.20	15.56	15.71
4-11-85	1430	15.59	15.19	14.60	13.91	13.11	12.33	11.53	10.78	10.10	9.47
4-11-85	1930	8.99	8.68	8.90	9.55	10.38	11.28	12.24	13.14	14.01	14.78
4-12-85	30	15.37	15.79	16.04	16.28	16.37	16.34	16.21	15.90	15.37	14.61
4-12-85	530	13.72	12.83	11.98	11.14	10.40	9.71	9.13	8.84	9.30	10.02
4-12-85	1030	10.71	11.45	12.18	12.90	13.63	14.16	14.51	14.89	15.12	15.10
4-12-85	1530	14.83	14.44	13.98	13.35	12.68	12.03	11.38	10.76	10.17	9.58
4-12-85	2030	9.09	8.77	8.94	9.43	10.15	10.93	11.80	12.69	13.51	14.29
4-13-85	130	14.93	15.39	15.73	16.04	16.17	16.12	15.99	15.67	15.14	14.49

(Continued)

(Sheet 3 of 4)

Table A7 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4-13-85	630	13.69	12.82	12.02	11.23	10.51	9.82	9.24	9.02	9.33	9.86
4-13-85	1130	10.52	11.27	12.09	12.90	13.67	14.42	14.95	15.27	15.65	15.82
4-13-85	1630	15.67	15.33	14.96	14.52	13.89	13.16	12.49	11.79	11.14	10.63
4-13-85	2130	10.24	9.95	10.12	10.64	11.28	11.97	12.63	13.30	13.99	14.58
4-14-85	230	15.10	15.46	15.78	16.05	16.14	16.12	16.03	15.85	15.51	15.02
4-14-85	730	14.38	13.62	12.86	12.15	11.45	10.80	10.21	9.69	9.34	9.53
4-14-85	1230	10.22	11.00	11.87	12.81	13.68	14.47	15.06	15.45	15.78	16.06
4-14-85	1730	16.18	16.06	15.76	15.33	14.77	14.01	13.17	12.38	11.63	10.93
4-14-85	2230	10.33	9.87	9.64	9.88	10.36	10.99	11.83	12.66	13.60	14.41
4-15-85	330	15.05	15.51	15.83	16.11	16.29	16.34	16.30	16.13	15.78	15.25
4-15-85	830	14.54	13.69	12.81	11.99	11.20	10.48	9.80	9.20	9.07	9.71
4-15-85	1330	10.58	11.46	12.45	13.41	14.31	14.99	15.50	15.83	16.10	16.26
4-15-85	1830	16.26	16.16	15.86	15.35	14.66	13.85	13.02	12.21	11.41	10.71
4-15-85	2330	10.08	9.47	9.02	9.08	9.82	10.66	11.57	12.50	13.34	14.20
4-16-85	430	14.89	15.31	15.64	15.97	16.15	16.15	16.00	15.65	15.10	14.36
4-16-85	930	13.51	12.65	11.81	11.01	10.25	9.52	8.94	8.52	8.69	9.51
4-16-85	1430	10.44	11.51	12.57	13.60	14.54	15.20	15.63	15.89	16.15	16.26
4-16-85	1930	16.21	15.83	15.26	14.67	13.88	12.99	12.14	11.30	10.53	9.79
4-17-85	30	9.08	8.49	8.34	8.89	9.71	10.60	11.66	12.66	13.54	14.37
4-17-85	530	15.03	15.52	15.80	16.11	16.23	16.14	15.89	15.42	14.74	13.91
4-17-85	1030	13.01	12.13	11.24	10.43	9.63	8.91	8.49	8.85	9.60	10.53

(Sheet 4 of 4)

Table A8

Tidal Elevations, Tide Gage 9

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-21-85	1200	14.63	13.73	12.79	11.91	11.04	10.25	9.59	9.25	9.65	10.68
3-21-85	1700	11.70	12.76	14.02	15.18	16.15	16.72	17.02	17.19	17.37	17.38
3-21-85	2200	17.33	17.16	16.73	16.14	15.41	14.56	13.72	12.82	12.03	11.19
3-22-85	300	10.47	9.93	9.70	9.91	10.74	11.76	12.85	14.05	15.09	16.02
3-22-85	800	16.64	16.98	17.17	17.26	17.32	17.29	17.11	16.75	16.22	15.48
3-22-85	1300	14.66	13.79	12.89	12.04	11.23	10.52	9.99	9.83	10.32	11.36
3-22-85	1800	12.51	13.74	14.92	15.98	16.71	17.15	17.38	17.50	17.53	17.45
3-22-85	2300	17.25	16.92	16.35	15.63	14.82	13.97	13.07	12.22	11.41	10.68
3-23-85	400	10.08	9.73	9.73	10.33	11.28	12.33	13.40	14.49	15.41	16.16
3-23-85	900	16.68	16.93	17.04	17.06	16.99	16.73	16.28	15.58	14.75	13.87
3-23-85	1400	12.99	12.09	11.21	10.40	9.69	9.24	9.21	9.83	10.85	11.99
3-23-85	1900	13.24	14.47	15.56	16.40	16.93	17.17	17.27	17.30	17.21	16.98
3-24-85	0	16.57	15.96	15.14	14.29	13.39	12.51	11.69	10.89	10.23	9.72
3-24-85	500	9.44	9.53	10.20	11.11	12.10	13.17	14.24	15.11	15.80	16.28
3-24-85	1000	16.55	16.66	16.66	16.49	16.13	15.51	14.74	13.85	12.91	12.04
3-24-85	1500	11.17	10.34	9.55	8.91	8.52	8.53	9.30	10.43	11.54	12.77
3-24-85	2000	14.12	15.31	16.25	16.79	17.09	17.20	17.20	17.09	16.83	16.38
3-25-85	100	15.66	14.84	13.96	13.08	12.20	11.36	10.57	9.87	9.31	9.02
3-25-85	600	9.30	10.09	11.05	12.11	13.29	14.40	15.32	15.97	16.28	16.46
3-25-85	1100	16.48	16.39	16.15	15.68	15.03	14.25	13.38	12.60	11.82	11.07
3-25-85	1600	10.44	9.99	9.58	9.52	9.71	10.25	11.05	12.03	13.24	14.50
3-25-85	2100	15.46	16.31	16.95	17.19	17.27	17.31	17.24	17.08	16.73	16.17
3-26-85	200	15.42	14.62	13.80	12.98	12.25	11.55	10.98	10.61	10.33	10.45
3-26-85	700	11.01	11.79	12.62	13.55	14.47	15.18	15.69	16.05	16.32	16.44
3-26-85	1200	16.42	16.29	15.91	15.36	14.70	14.01	13.20	12.44	11.70	11.05
3-26-85	1700	10.51	10.15	9.82	10.00	10.64	11.50	12.41	13.48	14.58	15.50
3-26-85	2200	16.26	16.71	16.97	17.09	17.09	17.04	16.88	16.55	16.03	15.33
3-27-85	300	14.55	13.73	12.91	12.17	11.47	10.92	10.52	10.36	10.51	11.03
3-27-85	800	11.73	12.51	13.34	14.11	14.76	15.24	15.60	15.84	16.03	16.10
3-27-85	1300	15.95	15.64	15.23	14.71	14.03	13.22	12.51	11.83	11.17	10.55
3-27-85	1800	10.04	9.77	9.87	10.40	11.19	12.06	12.98	13.96	14.81	15.48
3-27-85	2300	15.99	16.30	16.50	16.61	16.60	16.41	16.07	15.49	14.82	14.09
3-28-85	400	13.29	12.51	11.82	11.20	10.68	10.24	9.96	9.93	10.30	10.96
3-28-85	900	11.66	12.39	13.04	13.68	14.20	14.63	14.90	15.07	15.16	15.10
3-28-85	1400	14.93	14.64	14.15	13.61	12.99	12.39	11.75	11.11	10.51	9.99

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

(Sheet 1 of 4)

Table A8 (Continued)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-28-85	1900	9.63	9.66	10.02	10.57	11.25	12.03	12.85	13.62	14.28	14.84
3-29-85	0	15.25	15.62	15.87	15.99	15.99	15.77	15.41	14.91	14.29	13.60
3-29-85	500	12.84	12.13	11.43	10.84	10.36	10.02	9.90	10.01	10.37	10.86
3-29-85	1000	11.37	12.01	12.56	13.15	13.73	14.28	14.69	14.98	15.20	15.31
3-29-85	1500	15.16	14.81	14.34	13.70	12.96	12.18	11.37	10.71	10.21	9.80
3-29-85	2000	9.60	9.68	10.02	10.55	11.14	11.84	12.57	13.30	14.02	14.65
3-30-85	100	15.24	15.72	16.01	16.14	16.12	15.87	15.46	14.88	14.17	13.43
3-30-85	600	12.66	11.94	11.27	10.67	10.21	9.93	9.86	10.05	10.48	11.05
3-30-85	1100	11.60	12.24	12.88	13.57	14.18	14.65	15.06	15.32	15.41	15.38
3-30-85	1600	15.11	14.71	14.19	13.58	12.96	12.17	11.52	10.98	10.48	10.15
3-30-85	2100	10.01	10.02	10.18	10.59	11.08	11.72	12.46	13.18	13.96	14.73
3-31-85	200	15.42	16.02	16.39	16.53	16.55	16.43	16.08	15.57	14.88	14.06
3-31-85	700	13.19	12.38	11.63	10.93	10.40	9.97	9.75	9.79	10.12	10.73
3-31-85	1200	11.39	12.11	12.88	13.66	14.39	14.99	15.46	15.78	15.96	16.00
3-31-85	1700	15.80	15.43	14.95	14.36	13.65	12.93	12.22	11.53	10.87	10.29
3-31-85	2200	9.80	9.53	9.44	9.56	10.03	10.72	11.53	12.41	13.37	14.42
4- 1-85	300	15.33	16.13	16.61	16.78	16.76	16.66	16.39	15.85	15.12	14.26
4- 1-85	800	13.34	12.40	11.50	10.69	9.99	9.38	8.97	8.85	9.12	9.78
4- 1-85	1300	10.67	11.51	12.51	13.43	14.32	15.12	15.72	16.12	16.31	16.36
4- 1-85	1800	16.23	15.89	15.36	14.61	13.78	12.86	12.02	11.21	10.50	9.79
4- 1-85	2300	9.18	8.74	8.52	8.77	9.45	10.40	11.33	12.44	13.61	14.65
4- 2-85	400	15.51	16.12	16.46	16.63	16.66	16.56	16.32	15.94	15.32	14.56
4- 2-85	900	13.66	12.73	11.86	11.05	10.32	9.66	9.14	8.85	8.95	9.59
4- 2-85	1400	10.62	11.61	12.71	13.84	14.91	15.83	16.46	16.84	17.01	17.02
4- 2-85	1900	16.93	16.69	16.25	15.52	14.65	13.69	12.73	11.79	10.87	10.01
4- 3-85	0	9.21	8.51	7.99	8.05	9.03	10.34	11.59	12.94	14.32	15.53
4- 3-85	500	16.52	17.15	17.47	17.63	17.70	17.67	17.46	17.10	16.59	15.84
4- 3-85	1000	14.96	14.06	13.09	12.16	11.24	10.40	9.68	9.15	8.92	9.44
4- 3-85	1500	10.63	11.86	13.10	14.38	15.47	16.39	17.01	17.38	17.57	17.65
4- 3-85	2000	17.60	17.41	17.06	16.53	15.75	14.87	13.94	12.97	11.96	10.97
4- 4-85	100	9.97	9.07	8.36	7.90	8.21	9.52	10.93	12.23	13.66	14.94
4- 4-85	600	16.10	16.88	17.33	17.55	17.61	17.53	17.27	16.83	16.24	15.37
4- 4-85	1100	14.48	13.51	12.52	11.48	10.54	9.60	8.78	8.20	8.02	8.85
4- 4-85	1600	10.28	11.59	12.96	14.32	15.59	16.62	17.25	17.59	17.82	17.95
4- 4-85	2100	17.96	17.77	17.37	16.83	16.13	15.32	14.41	13.40	12.35	11.32

(Continued)

(Sheet 2 of 4)

Table A8 (Continued)

DATE	TIME OF FIRST READING EST					ELEVATION FT					
4- 5-85	200	10.31	9.36	8.58	8.11	8.53	10.00	11.46	12.86	14.29	15.59
4- 5-85	700	16.60	17.22	17.55	17.71	17.76	17.69	17.39	16.91	16.22	15.42
4- 5-85	1200	14.55	13.62	12.58	11.54	10.56	9.63	8.81	8.22	8.29	9.59
4- 5-85	1700	11.07	12.48	13.88	15.28	16.53	17.27	17.70	17.98	18.21	18.34
4- 5-85	2200	18.33	18.08	17.64	17.07	16.39	15.67	14.74	13.78	12.71	11.68
4- 6-85	300	10.70	9.78	8.97	8.45	8.64	10.08	11.57	12.92	14.26	15.50
4- 6-85	800	16.49	17.05	17.37	17.52	17.52	17.32	16.91	16.30	15.46	14.60
4- 6-85	1300	13.65	12.64	11.57	10.56	9.58	8.67	7.94	7.44	8.13	9.60
4- 6-85	1800	11.02	12.38	13.72	15.09	16.31	17.09	17.55	17.88	18.09	18.17
4- 6-85	2300	18.10	17.73	17.25	16.61	15.87	15.02	14.12	13.11	12.08	11.06
4- 7-85	400	10.12	9.25	8.59	8.37	9.48	10.93	12.25	13.53	14.74	15.86
4- 7-85	900	16.67	17.17	17.42	17.49	17.40	17.13	16.70	16.06	15.19	14.32
4- 7-85	1400	13.34	12.38	11.37	10.39	9.45	8.62	8.03	8.00	9.11	10.53
4- 7-85	1900	11.88	13.24	14.62	15.84	16.76	17.31	17.67	17.90	18.06	18.09
4- 8-85	0	17.95	17.55	17.00	16.34	15.55	14.70	13.77	12.74	11.76	10.76
4- 8-85	500	9.87	9.11	8.65	8.98	10.25	11.50	12.67	13.93	15.06	16.06
4- 8-85	1000	16.75	17.14	17.28	17.28	17.06	16.68	16.09	15.31	14.46	13.54
4- 8-85	1500	12.59	11.65	10.72	9.83	9.05	8.48	8.35	9.13	10.39	11.62
4- 8-85	2000	12.86	14.10	15.28	16.30	16.97	17.34	17.59	17.73	17.74	17.58
4- 9-85	100	17.30	16.85	16.17	15.33	14.47	13.56	12.61	11.61	10.66	9.81
4- 9-85	600	9.09	8.59	8.68	9.63	10.82	11.88	12.95	13.96	14.84	15.50
4- 9-85	1100	16.04	16.47	16.61	16.53	16.40	15.98	15.27	14.43	13.51	12.62
4- 9-85	1600	11.70	10.78	9.93	9.16	8.57	8.31	8.71	9.72	10.93	12.08
4- 9-85	2100	13.32	14.52	15.58	16.42	16.97	17.32	17.50	17.57	17.58	17.45
4-10-85	200	17.11	16.58	15.86	15.03	14.14	13.20	12.37	11.55	10.82	10.22
4-10-85	700	9.89	9.90	10.37	11.22	12.15	13.16	14.16	14.99	15.73	16.25
4-10-85	1200	16.58	16.77	16.84	16.78	16.53	16.11	15.43	14.64	13.79	12.97
4-10-85	1700	12.18	11.43	10.78	10.25	9.90	9.80	10.09	10.76	11.63	12.57
4-10-85	2200	13.58	14.55	15.44	16.20	16.75	17.15	17.36	17.42	17.41	17.29
4-11-85	300	17.05	16.58	15.81	14.96	14.06	13.13	12.25	11.40	10.67	10.11
4-11-85	800	9.74	9.68	10.22	11.04	11.85	12.69	13.58	14.36	15.07	15.65
4-11-85	1300	16.17	16.35	16.40	16.34	15.96	15.35	14.60	13.80	12.98	12.18
4-11-85	1800	11.41	10.77	10.25	9.85	9.53	9.44	9.89	10.69	11.54	12.46
4-11-85	2300	13.45	14.41	15.24	16.01	16.58	16.91	17.06	17.09	17.07	16.91
4-12-85	400	16.56	15.97	15.13	14.26	13.36	12.48	11.64	10.94	10.36	9.88

(Continued)

(Sheet 3 of 4)

Table A8 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
4-12-85	900	9.59	9.71	10.38	11.20	11.94	12.69	13.47	14.19	14.91	15.42
4-12-85	1400	15.67	15.81	15.83	15.59	15.25	14.73	14.12	13.43	12.73	12.08
4-12-85	1900	11.45	10.85	10.33	9.92	9.63	9.58	9.96	10.52	11.30	12.12
4-13-85	0	13.03	13.98	14.78	15.52	16.17	16.58	16.78	16.88	16.86	16.71
4-13-85	500	16.37	15.86	15.14	14.27	13.38	12.59	11.79	11.08	10.45	10.03
4-13-85	1000	9.83	9.95	10.39	10.96	11.66	12.50	13.35	14.21	14.96	15.68
4-13-85	1500	16.21	16.42	16.50	16.40	16.17	15.80	15.24	14.57	13.86	13.12
4-13-85	2000	12.46	11.87	11.40	11.05	10.76	10.72	11.08	11.69	12.41	13.16
4-14-85	100	13.88	14.58	15.23	15.82	16.30	16.60	16.77	16.85	16.86	16.37
4-14-85	600	16.58	16.22	15.71	15.02	14.27	13.50	12.77	12.09	11.43	10.89
4-14-85	1100	10.49	10.22	10.18	10.50	11.27	12.15	13.07	14.09	15.00	15.75
4-14-85	1600	16.33	16.66	16.86	16.89	16.77	16.48	16.11	15.42	14.63	13.80
4-14-85	2100	12.99	12.25	11.56	11.05	10.68	10.52	10.57	10.85	11.42	12.16
4-15-85	200	13.04	14.01	14.91	15.72	16.33	16.72	16.94	17.06	17.10	17.03
4-15-85	700	16.82	16.47	15.88	15.12	14.27	13.41	12.59	11.83	11.10	10.49
4-15-85	1200	10.01	9.81	10.07	10.81	11.77	12.68	13.73	14.74	15.64	16.32
4-15-85	1700	16.76	16.97	17.05	17.04	16.89	16.55	16.00	15.28	14.47	13.60
4-15-85	2200	12.79	12.04	11.32	10.74	10.21	9.86	9.76	10.09	10.94	11.87
4-16-85	300	12.81	13.79	14.72	15.53	16.15	16.57	16.79	16.89	16.89	16.70
4-16-85	800	16.34	15.72	14.91	14.09	13.15	12.34	11.52	10.79	10.18	9.67
4-16-85	1300	9.29	9.22	9.73	10.69	11.67	12.73	13.87	14.90	15.84	16.47
4-16-85	1800	16.79	16.93	17.04	16.86	16.42	16.03	15.34	14.47	13.52	12.64
4-16-85	2300	11.83	11.07	10.35	9.70	9.18	8.98	9.31	10.05	10.95	11.81
4-17-85	400	12.90	13.95	14.86	15.67	16.31	16.73	16.92	16.93	16.84	16.55
4-17-85	900	16.06	15.31	14.47	13.50	12.58	11.73	10.87	10.12	9.53	9.20

(Sheet 4 of 4)

Table A9

Tidal Elevations, Tide Gage 10

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-21-85	1000	15.90	15.71	15.34	14.71	13.97	13.17	12.34	11.51	10.67	9.90
3-21-85	1500	9.18	8.55	8.19	8.72	9.75	10.79	-9.99	13.23	14.35	15.09
3-21-85	2000	15.48	15.67	-9.99	-9.99	15.98	15.96	15.75	15.29	14.61	13.89
3-22-85	100	13.11	12.33	11.54	10.75	10.02	9.37	8.80	8.48	-9.99	9.84
3-22-85	600	10.88	12.05	13.21	14.24	15.00	15.43	15.65	15.79	15.88	15.92
3-22-85	1100	15.89	15.71	15.31	14.66	13.95	13.17	-9.99	11.58	10.78	10.06
3-22-85	1600	9.40	8.85	8.62	9.42	10.47	11.70	12.93	14.11	15.00	15.51
3-22-85	2100	15.80	15.97	16.07	16.11	16.05	15.87	15.49	14.89	14.17	13.40
3-23-85	200	12.58	11.79	11.00	10.25	9.59	8.99	8.57	8.53	9.42	10.41
3-23-85	700	11.51	12.58	13.65	14.49	15.07	15.43	15.61	15.68	15.70	15.59
3-23-85	1200	15.24	14.66	13.15	13.19	12.40	11.61	10.81	10.06	9.34	8.68
3-23-85	1700	8.19	8.05	8.10	9.16	11.17	12.44	13.70	14.67	15.32	15.66
3-23-85	2200	15.03	15.91	15.94	15.86	15.60	15.10	14.40	13.66	12.85	12.07
3-24-85	300	11.26	10.48	9.79	9.14	8.60	8.27	8.40	9.24	10.20	11.26
3-24-85	800	12.35	13.38	14.19	14.74	15.09	15.28	15.34	15.27	14.97	14.47
3-24-85	1300	13.83	13.13	12.33	11.53	10.73	9.98	9.25	8.56	7.96	7.52
3-24-85	1800	7.43	8.39	15.14	9.71	10.44	11.21	11.90	12.49	13.70	13.83
3-24-85	2300	13.85	13.73	13.52	13.21	12.70	12.16	11.59	11.02	10.44	9.87
3-25-85	400	9.31	8.79	8.40	8.27	8.67	9.33	10.03	10.82	14.25	14.52
3-25-85	900	14.67	14.67	14.49	14.17	13.70	13.16	12.52	11.87	11.20	10.53
3-25-85	1400	9.95	9.40	8.93	8.62	8.53	12.89	13.36	-9.99	11.17	11.93
3-25-85	1900	13.63	14.71	14.35	13.82	13.28	12.59	11.89	11.20	10.52	9.91
3-26-85	0	13.71	13.27	12.76	12.18	10.15	-9.99	-9.99	-9.99	-9.99	-9.99
3-26-85	500	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-26-85	1000	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-26-85	1500	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-26-85	2000	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	100	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	600	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	1100	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	1600	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-27-85	2100	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	200	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	700	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	1200	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99

(Continued)

Note: Sequential elevations printed horizontally at 30-min increments.

Table A9 (Concluded)

DATE	TIME OF FIRST READING EST	ELEVATION FT									
3-28-85	1700	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-28-85	2200	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	300	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	800	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	1300	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	1800	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-29-85	2300	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	400	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	900	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	1400	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-30-85	1900	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	0	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	500	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	1000	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	1500	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
3-31-85	2000	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
4- 1-85	100	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
4- 1-85	600	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	9.57	8.87
4- 1-85	1100	8.30	7.88	7.66	7.98	8.73	9.70	10.63	11.62	12.54	13.44
4- 1-85	1600	14.13	14.63	14.92	15.05	15.03	14.76	14.29	13.68	12.97	12.20
4- 1-85	2100	11.44	10.67	9.96	9.29	8.64	8.09	7.64	7.35	7.60	8.40
4- 2-85	200	9.37	10.43	11.60	12.73	13.76	14.50	14.96	15.22	15.34	15.35
4- 2-85	700	15.18	14.80	14.28	13.65	12.89	12.12	11.35	10.57	9.86	9.18
4- 2-85	1200	8.55	8.06	7.71	7.77	8.58	9.63	10.70	11.86	12.99	14.05
4- 2-85	1700	14.82	15.31	15.57	15.69	15.72	15.62	15.29	14.68	13.93	13.12
4- 2-85	2200	12.30	11.46	10.61	9.82	9.04	8.31	7.68	7.17	6.98	8.05
4- 3-85	300	9.27	10.63	12.09	13.48	14.62	15.40	15.81	16.04	16.20	16.28
4- 3-85	800	16.28	16.13	15.83	15.33	14.56	13.71	12.83	11.99	11.14	10.31
4- 3-85	1300	9.54	8.83	8.24	7.92	8.53	9.68	10.91	12.24	13.49	14.52
4- 3-85	1800	15.27	15.72	15.96	16.13	16.21	16.20	16.05	15.73	15.19	14.40
4- 3-85	2300	13.58	12.73	11.87	10.98	10.10	9.26	8.46	7.79	7.25	7.25
4- 4-85	400	8.56	9.90	11.37	12.73	14.11	15.09	15.64	24.21	24.21	24.21
4- 4-85	900	24.21	24.21	24.19	24.17	24.15	24.15	24.15	-9.99	-9.99	-9.99

APPENDIX B: VELOCITY DATA

Velocity data were collected at Ranges 8-12 on 3 April 1985 from 0600 to 1900 and at Ranges 1-7 on 4 April 1985 from 0600 to 1900. Measurements were taken at 1-hr intervals along the left (A) and right (C) channel prism line and in the center (B) of the channel at Ranges 1-6 and Range 7 in Front River. At Ranges 8-12, measurements were taken only in the center of the channel. Velocity plots are presented at the various ranges (labeled stations on the plots) in Figures B1-B29. The following notation is used to indicate the vertical location of the measurement:

S = Surface

1 = Two-thirds above the bottom

M = Middepth

2 = One-third above the bottom

N = 4 ft above bottom

B = 2 ft above bottom

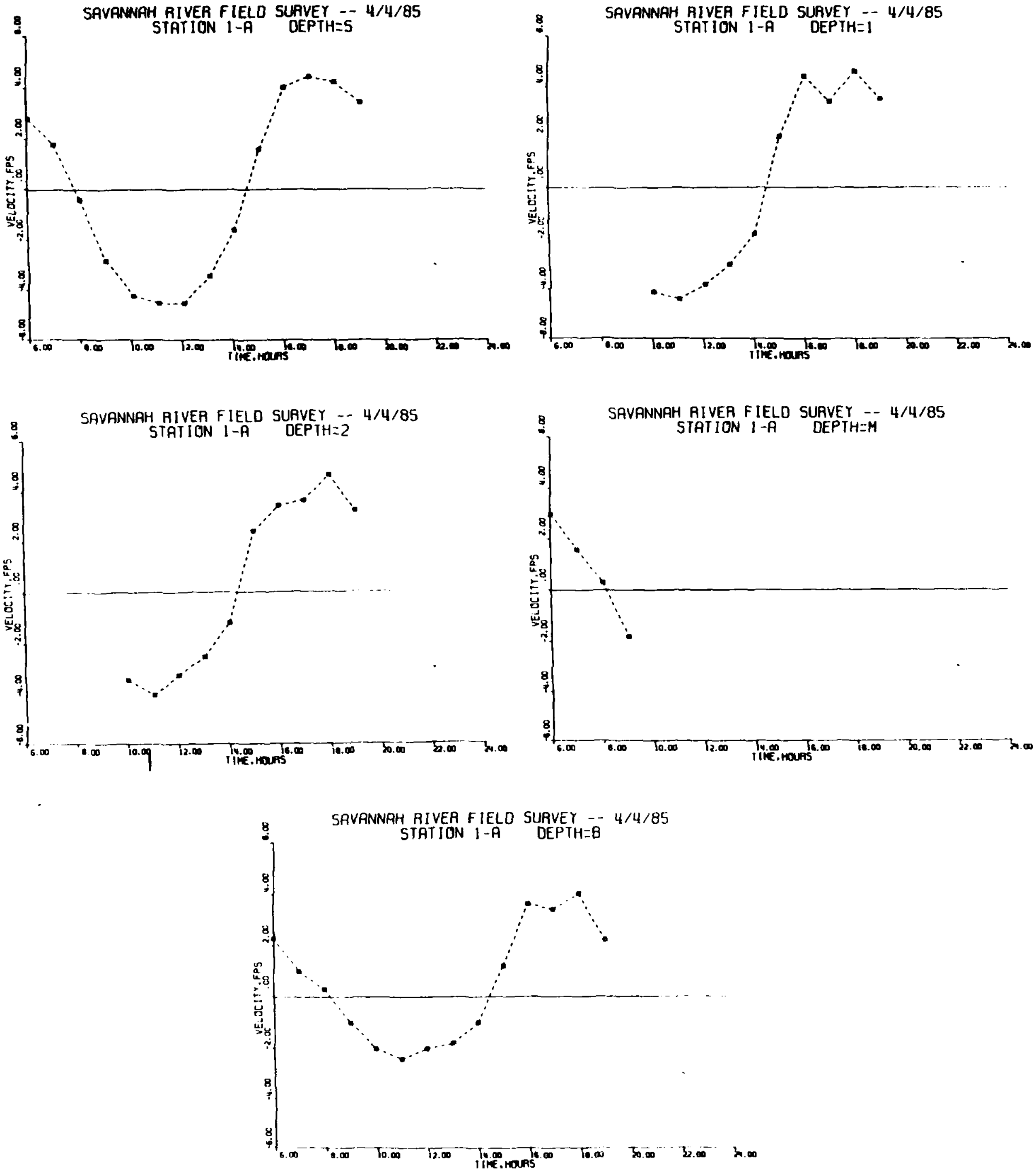


Figure B1. Velocity at sta 1 on left prism line

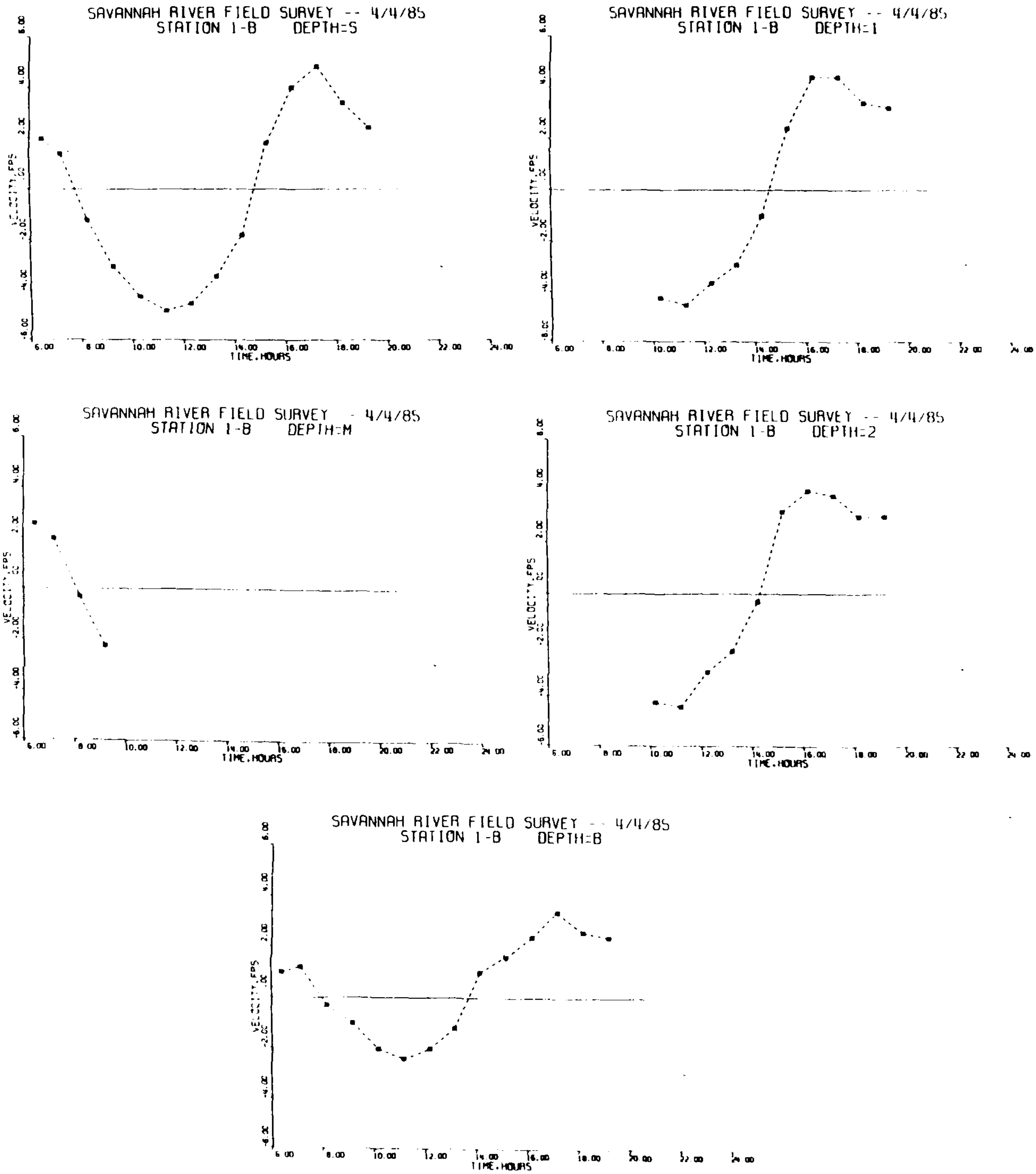


Figure B2. Velocity at sta 1 in center of channel

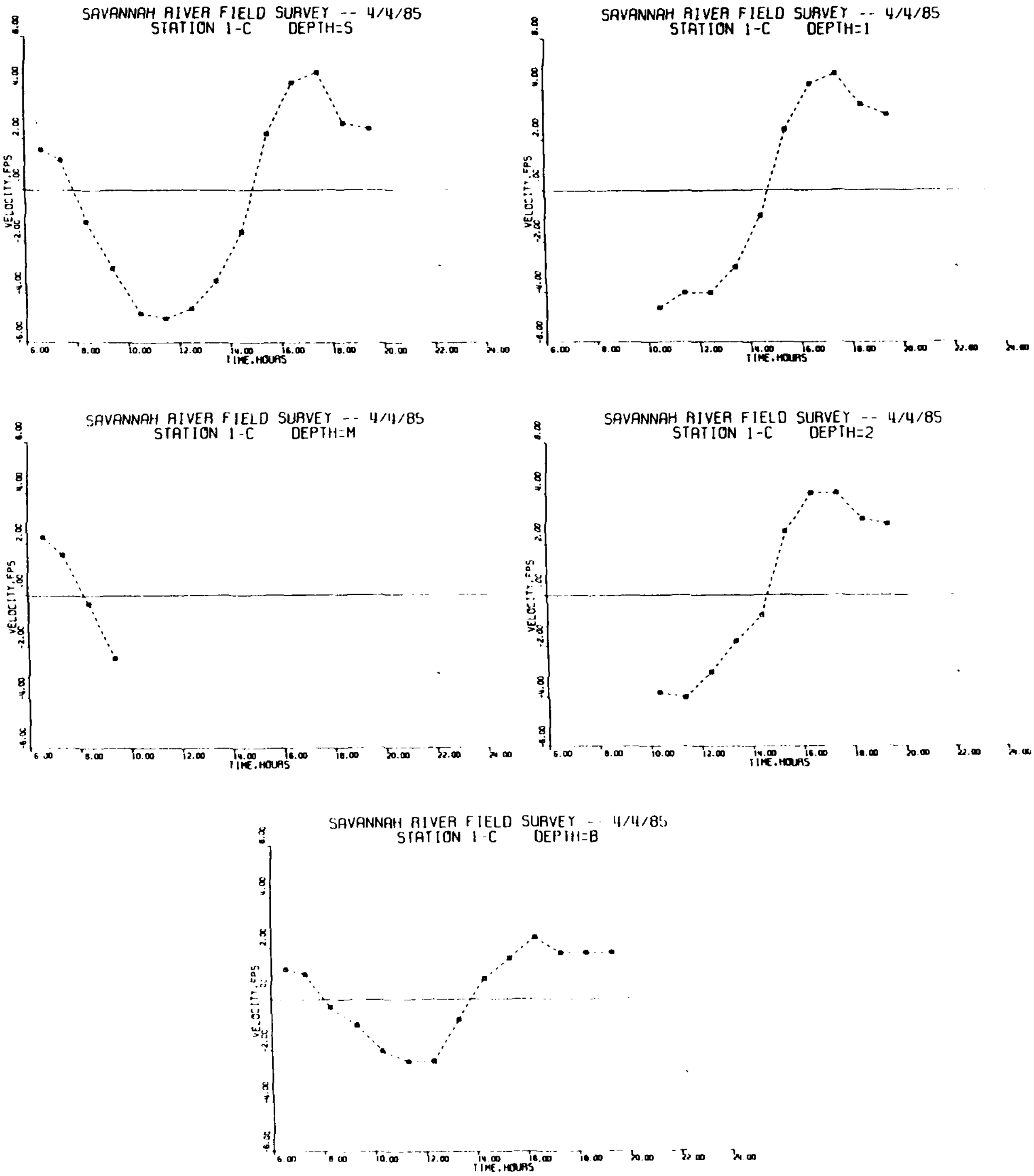


Figure B3. Velocity at sta 1 on right prism line

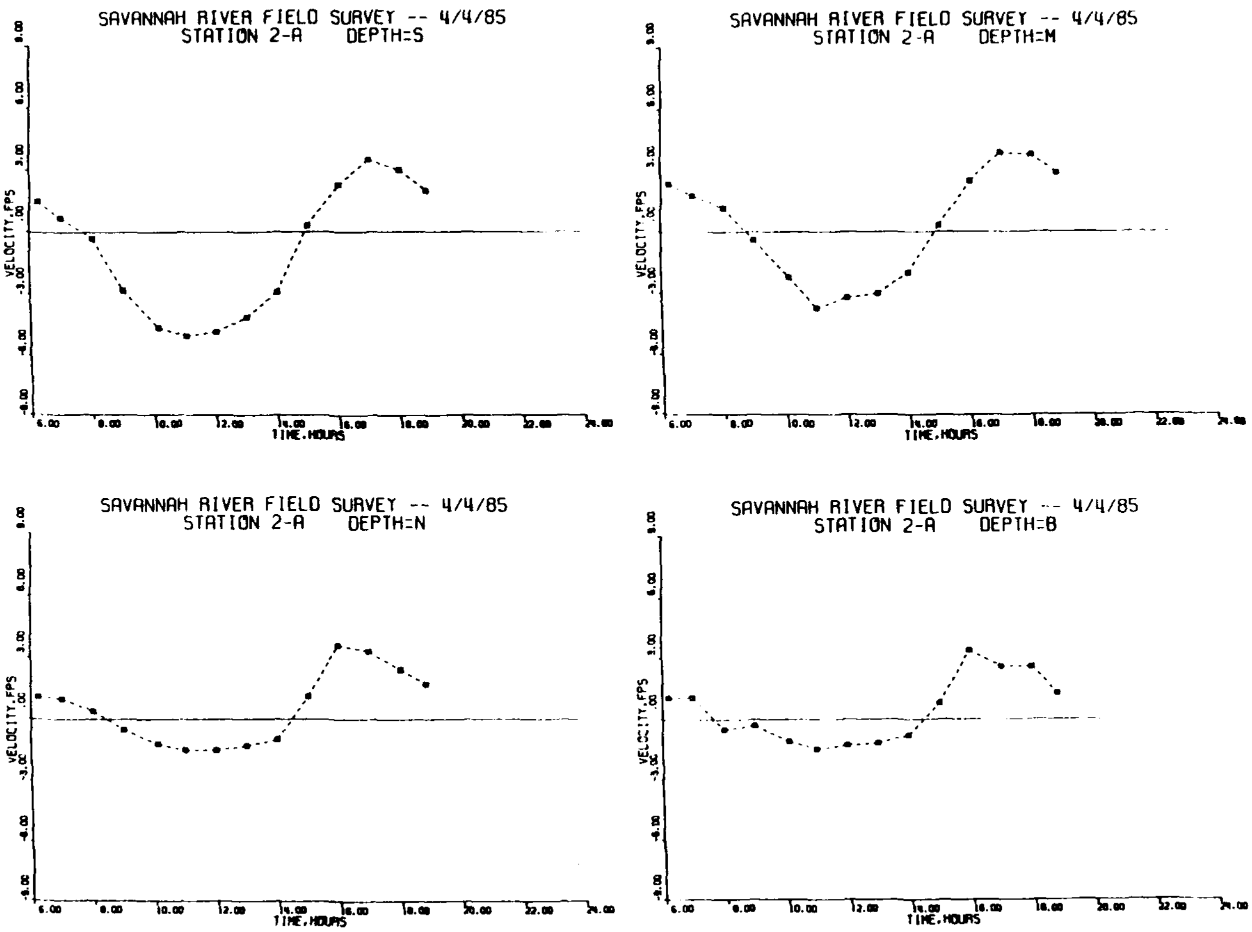


Figure B4. Velocity at sta 2 on left prism line

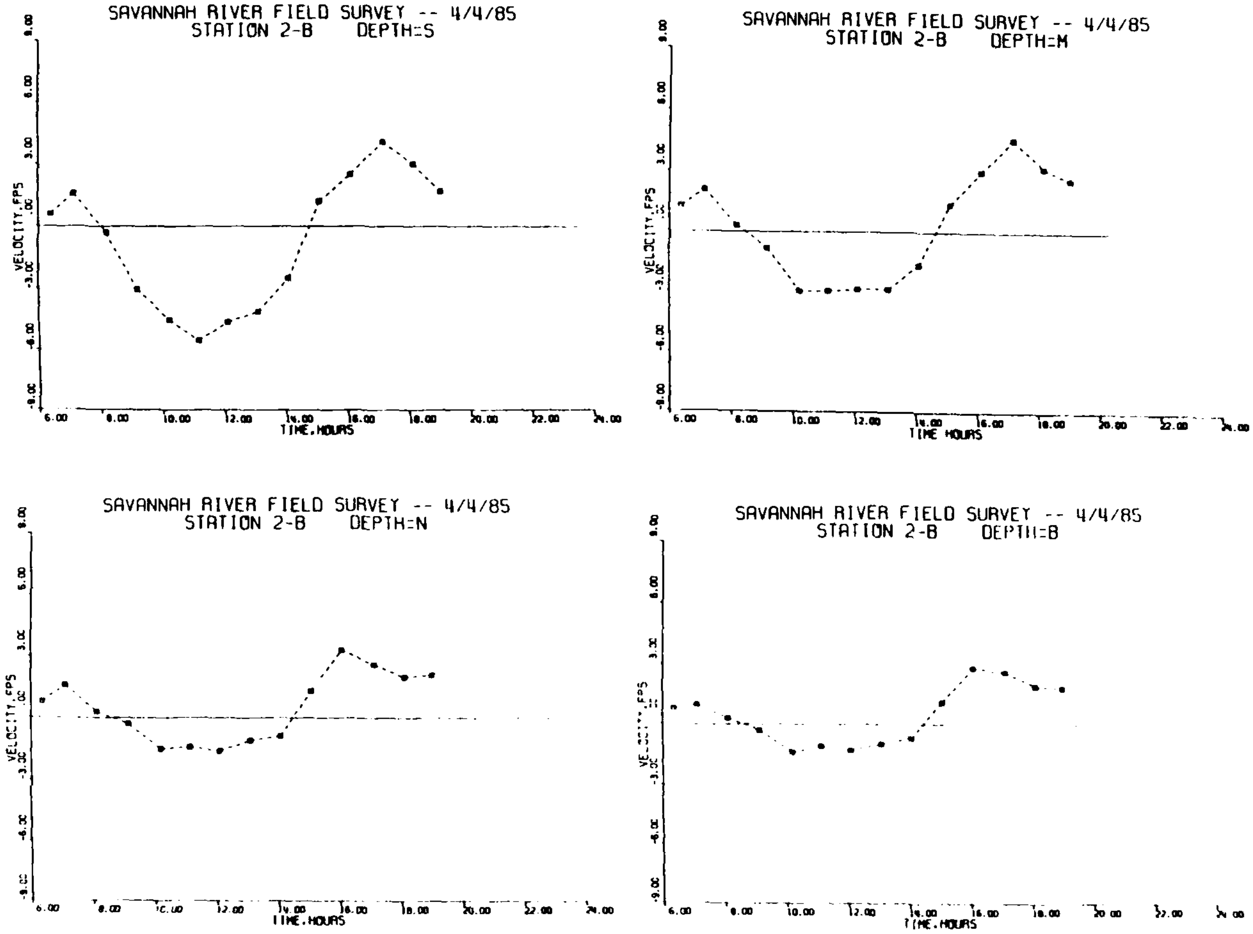


Figure B5. Velocity at sta 2 in center of channel

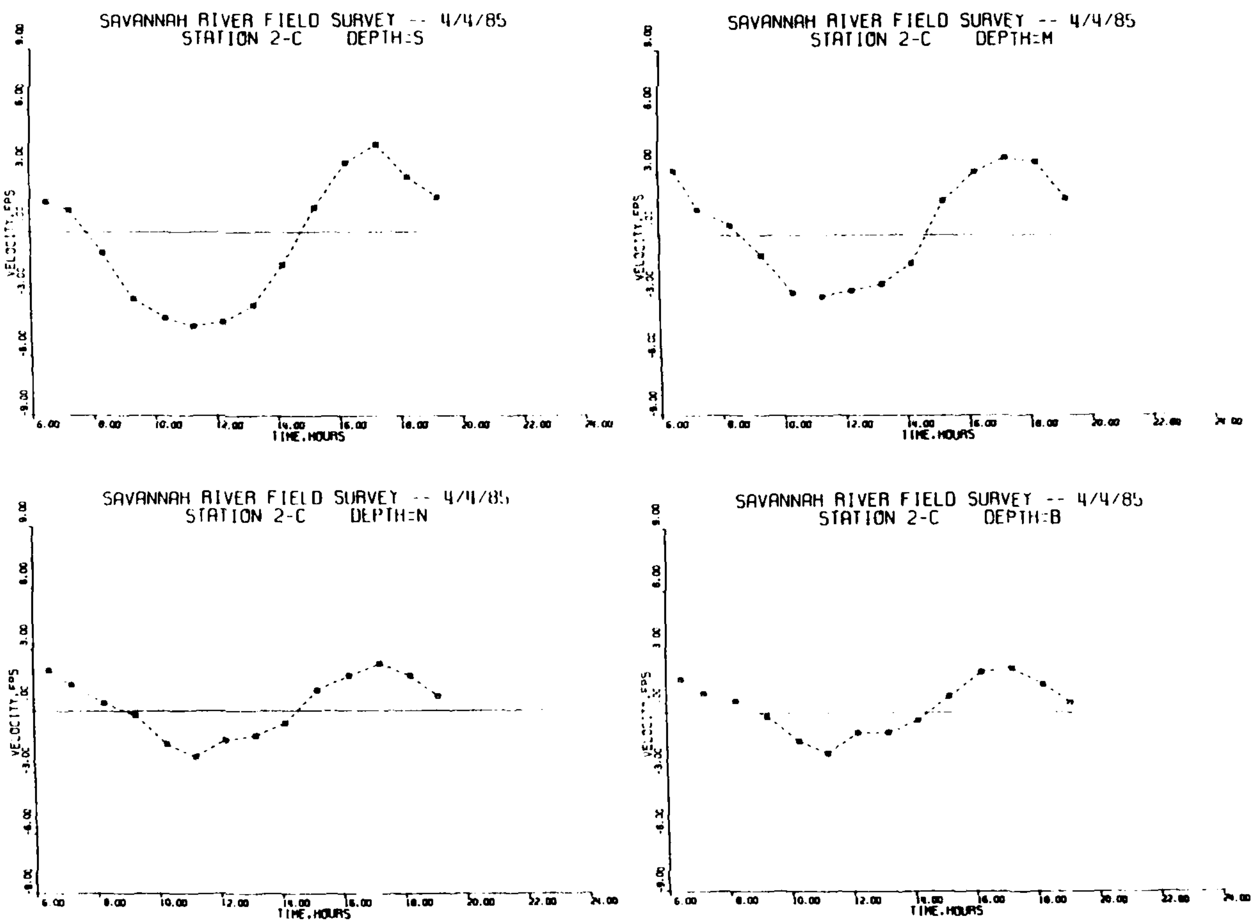


Figure B6. Velocity at sta 2 on right prism line

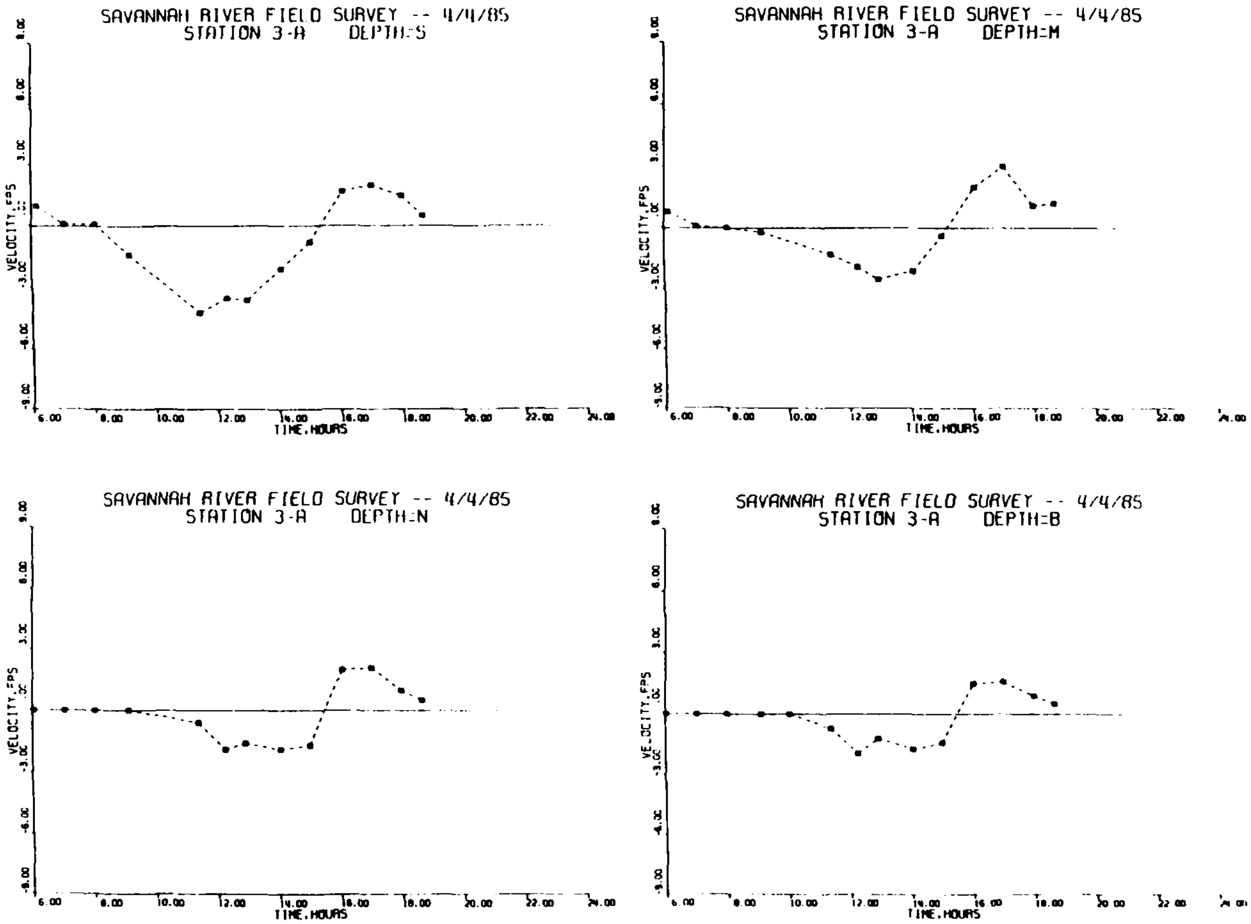


Figure B7. Velocity at sta 3 on left prism line

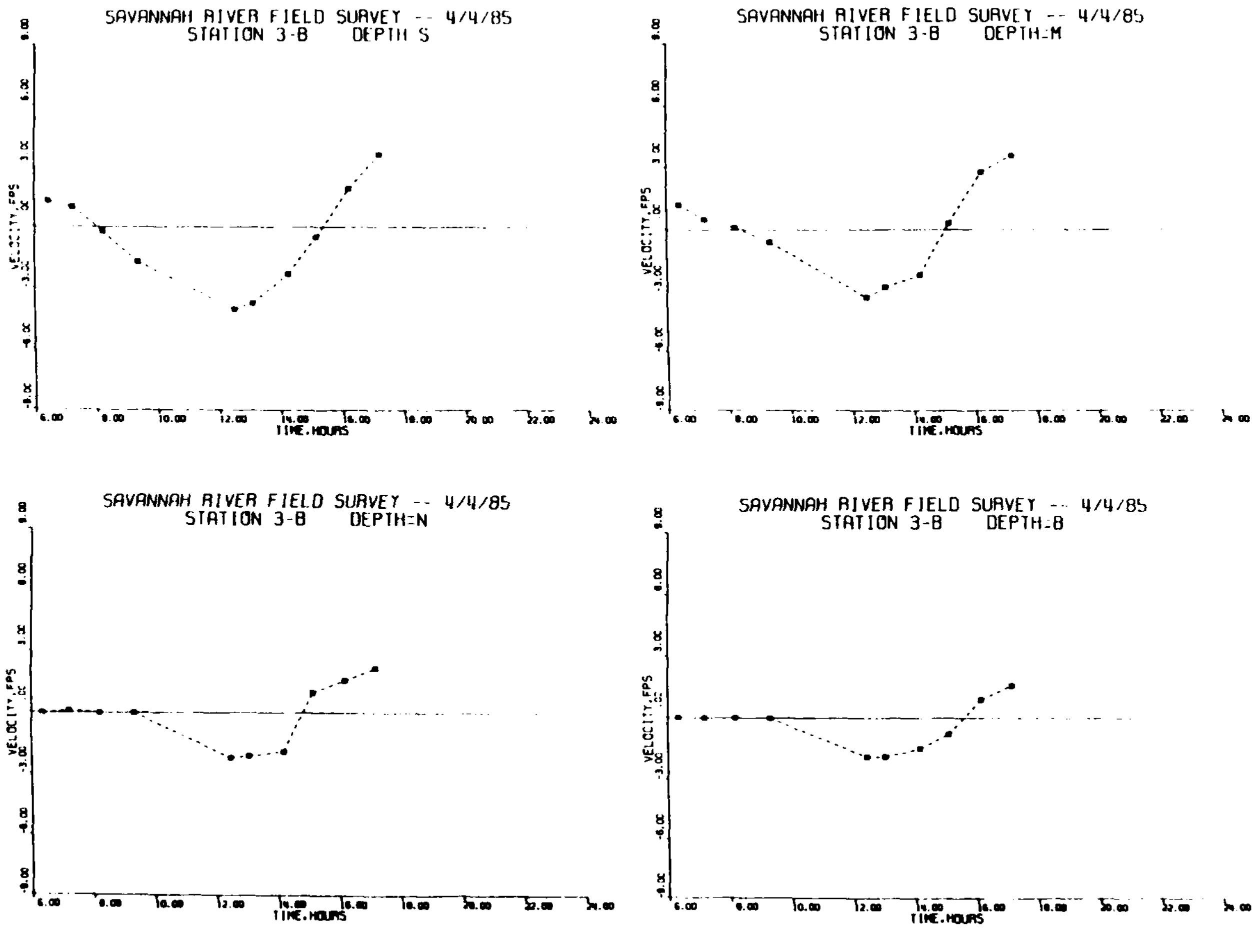


Figure B8. Velocity at sta 3 in center of channel

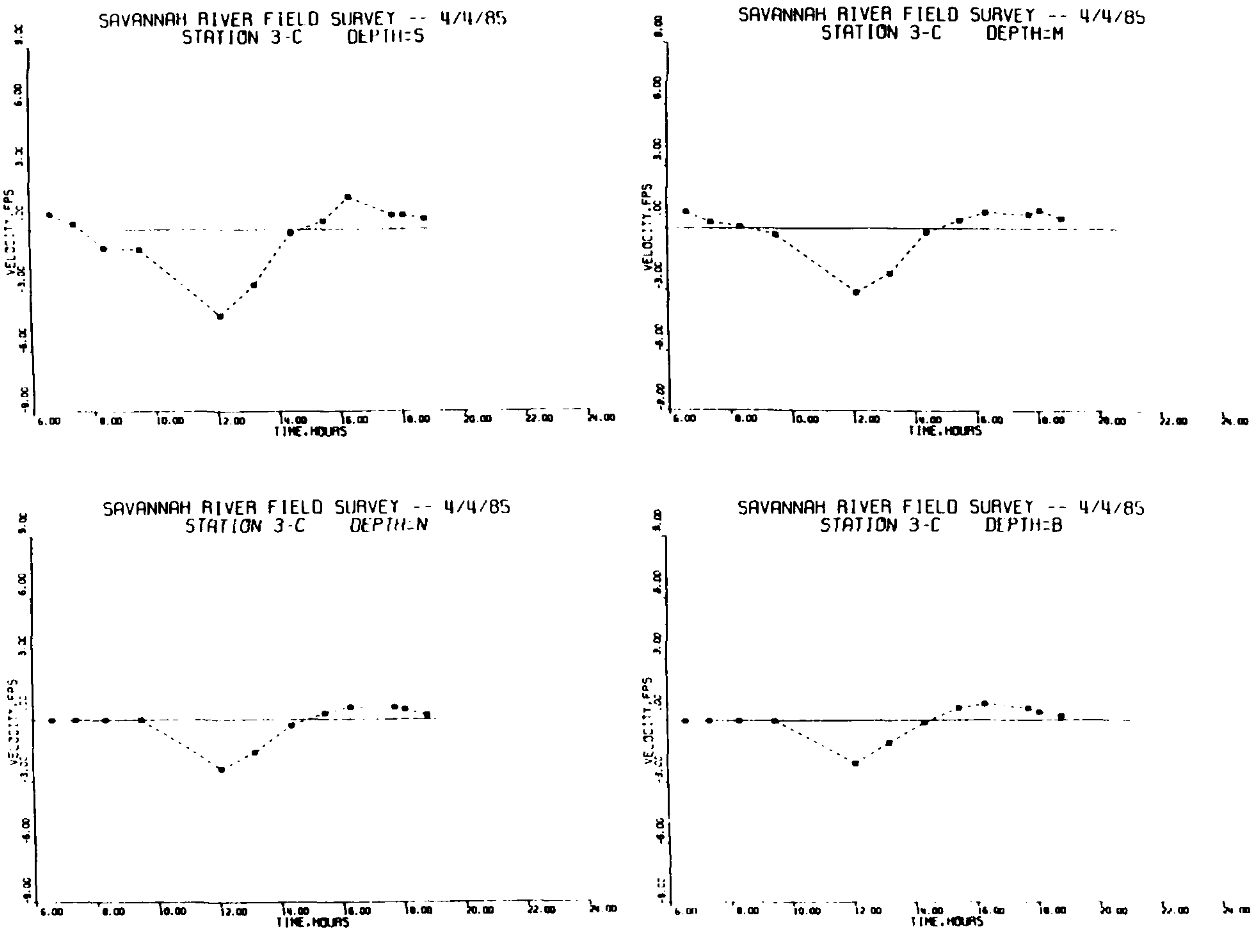


Figure B9. Velocity at sta 3 on right prism line

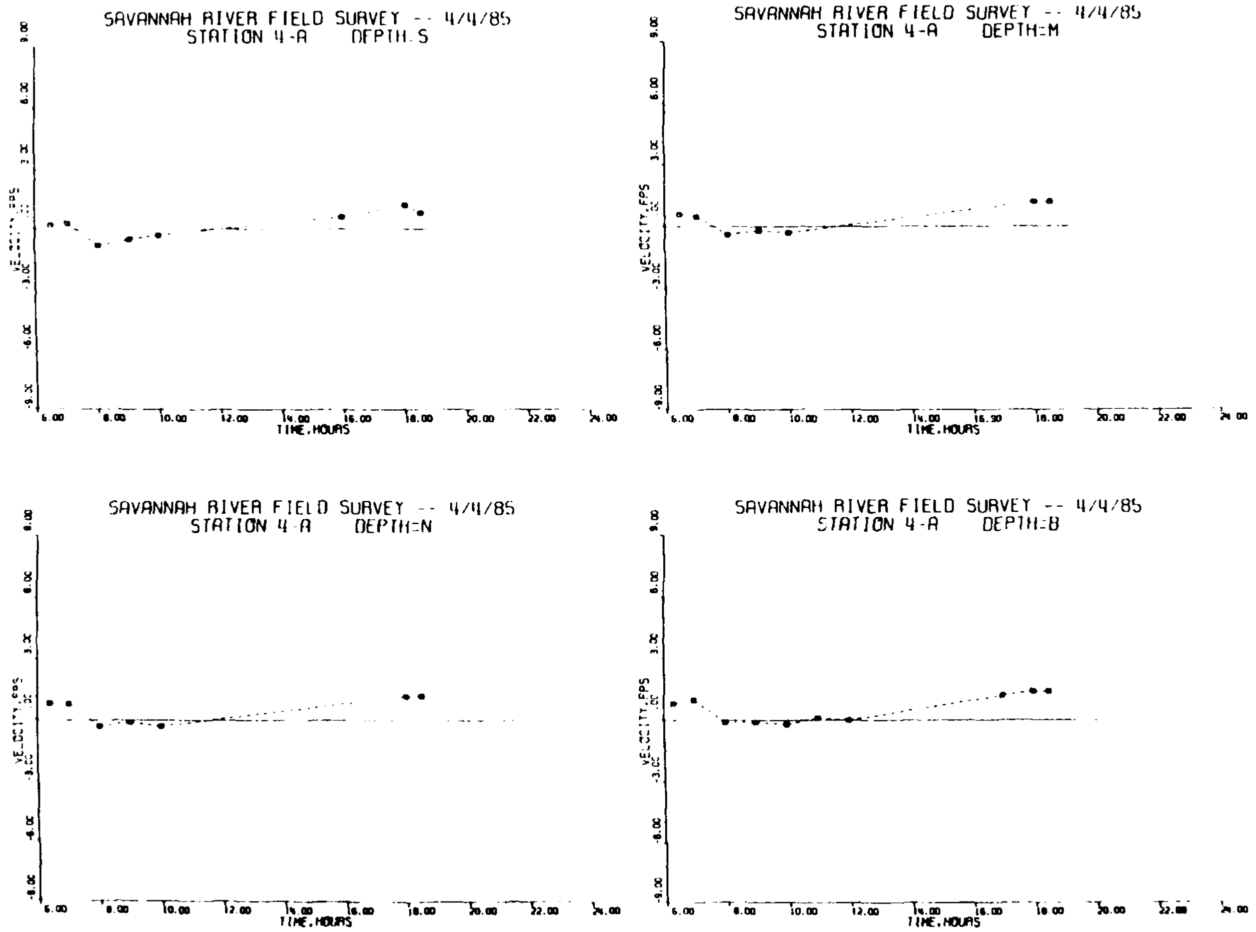


Figure B10. Velocity at sta 4 on left prism line

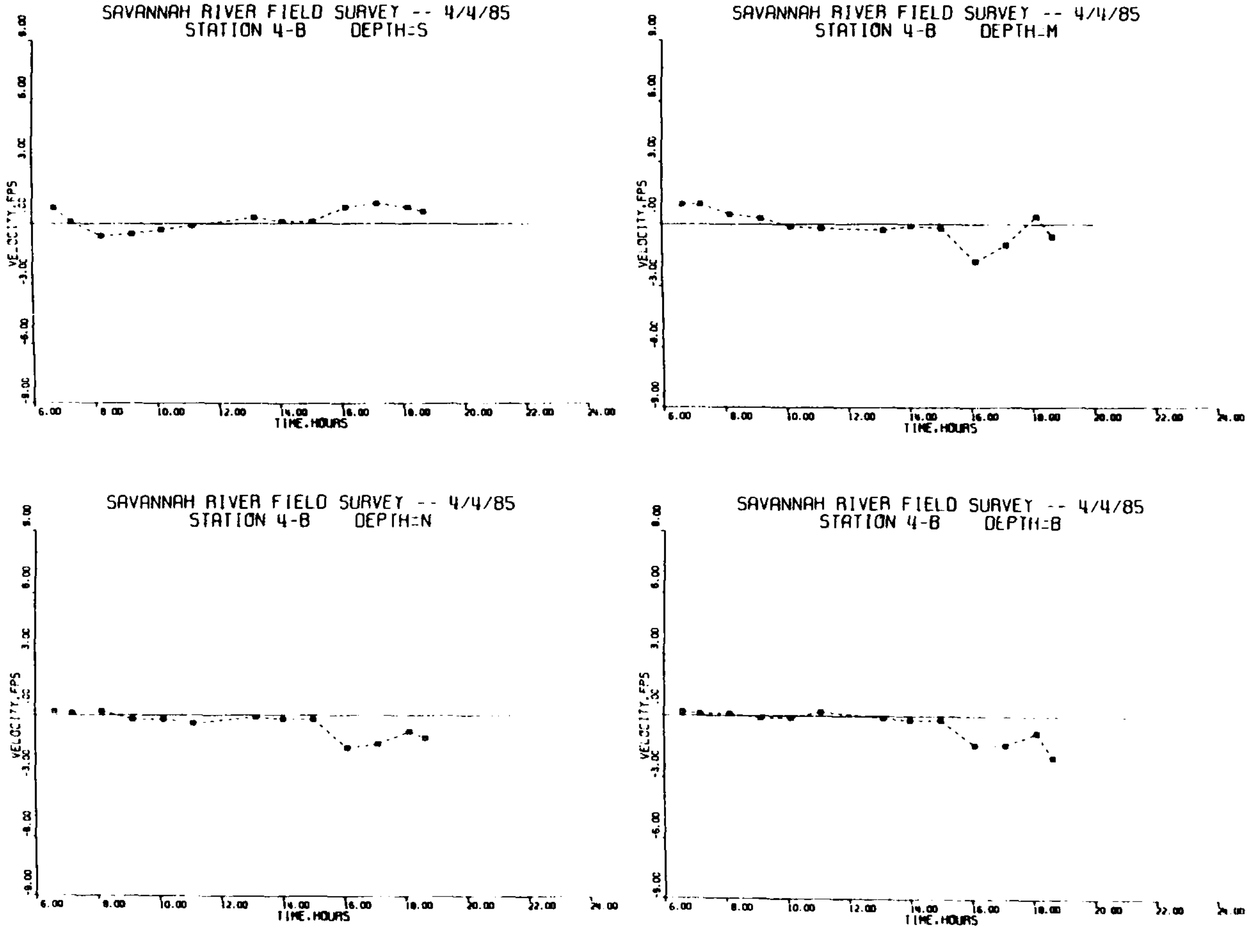


Figure B11. Velocity at sta 4 in center of channel

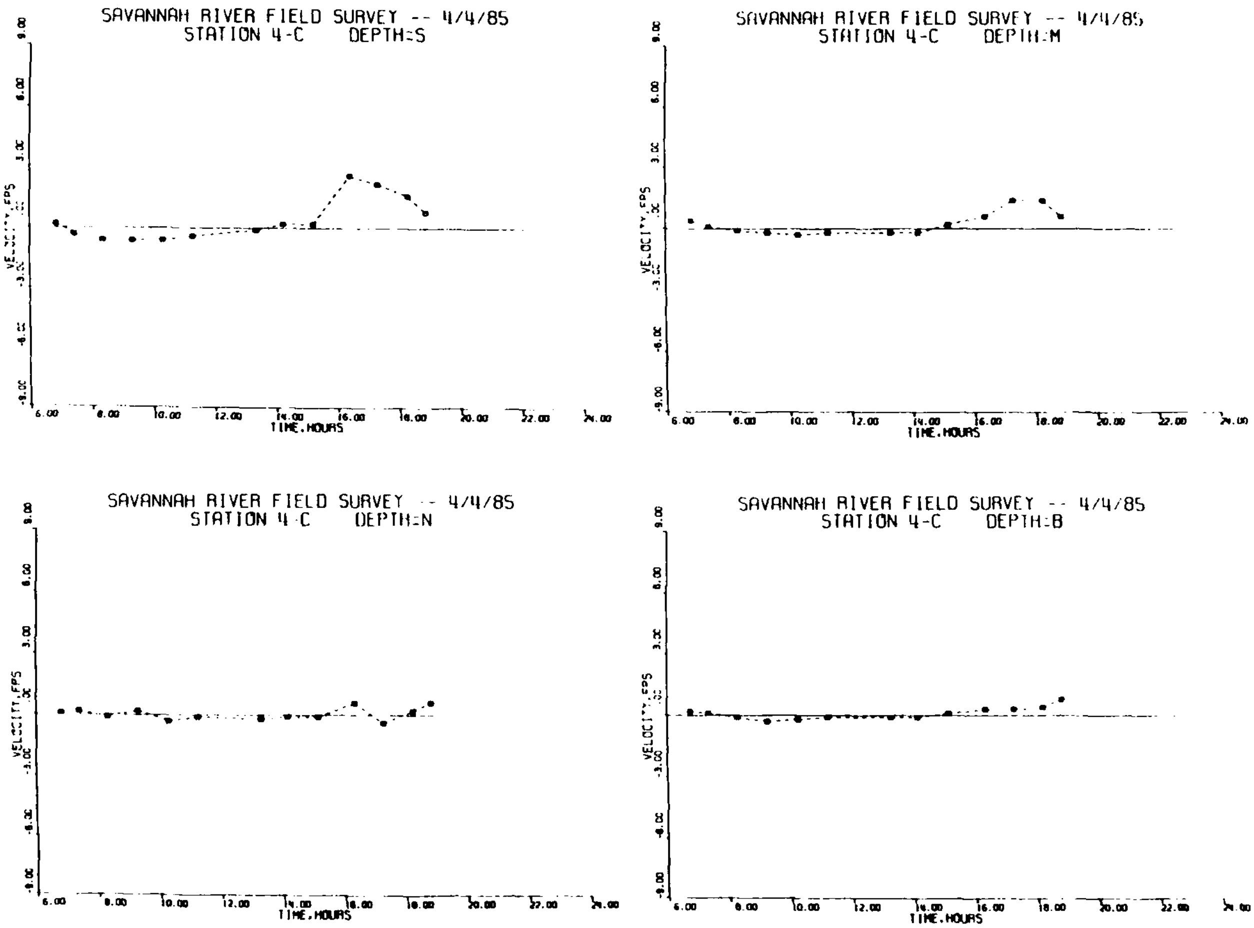


Figure B12. Velocity at sta 4 on right prism line

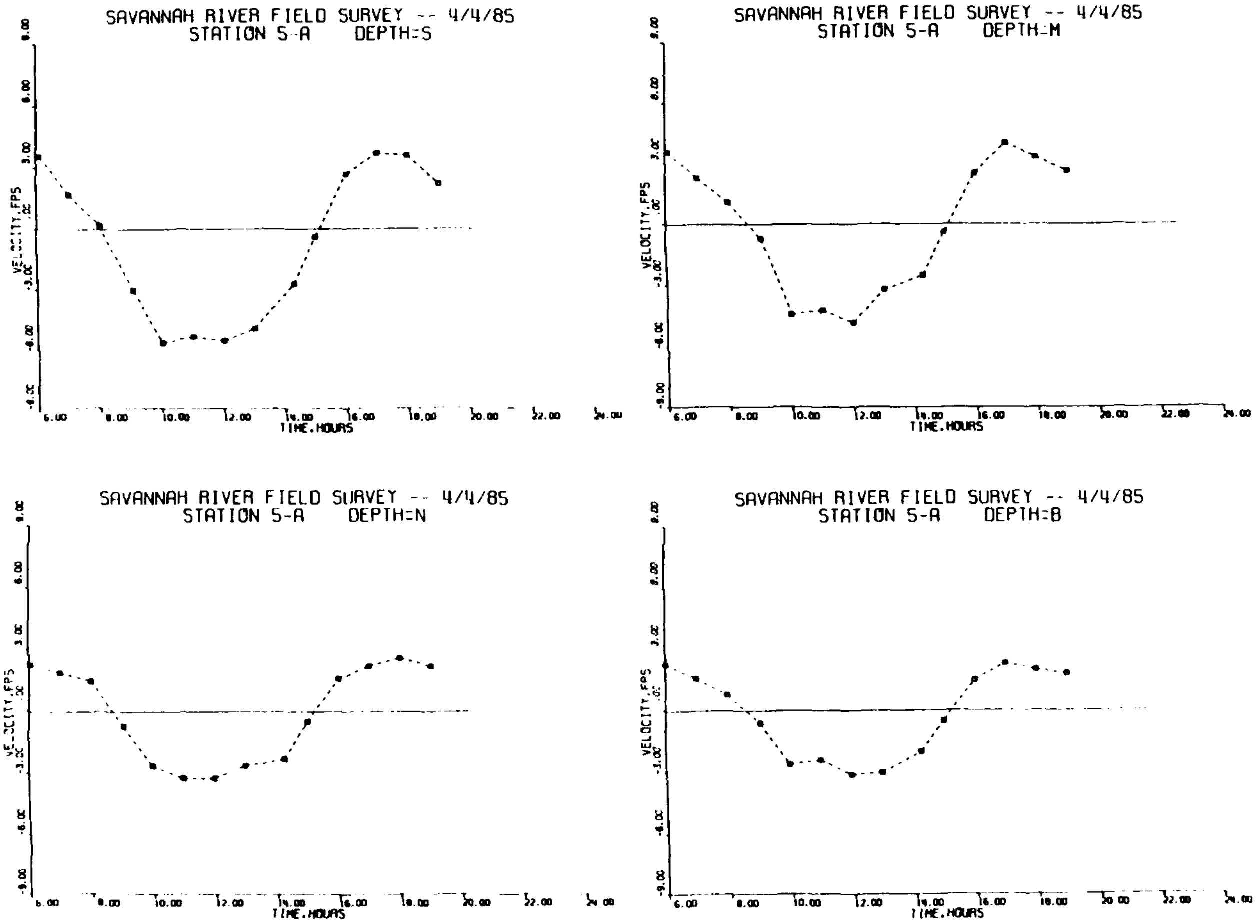


Figure B13. Velocity at sta 5 on left prism line

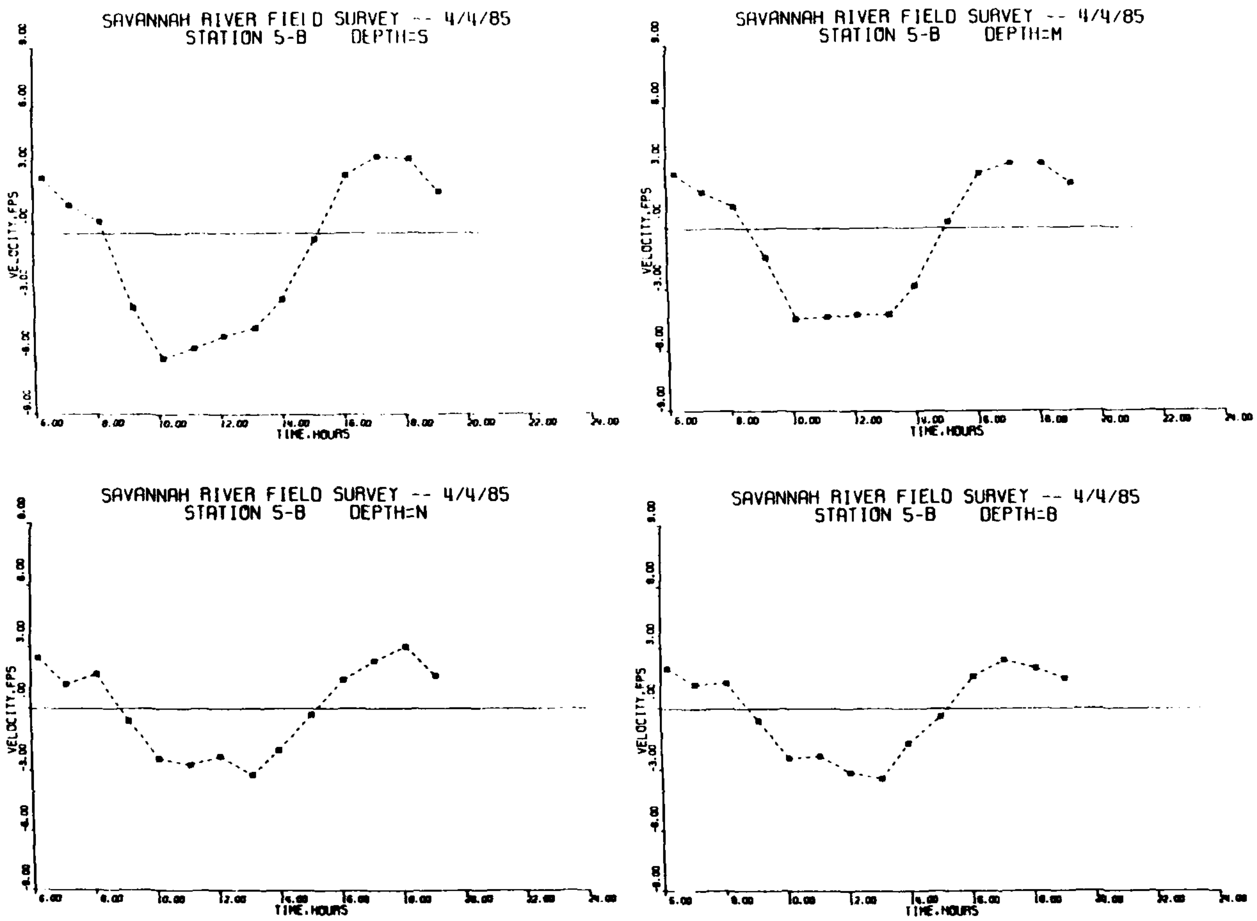


Figure B14. Velocity at sta 5 in center of channel

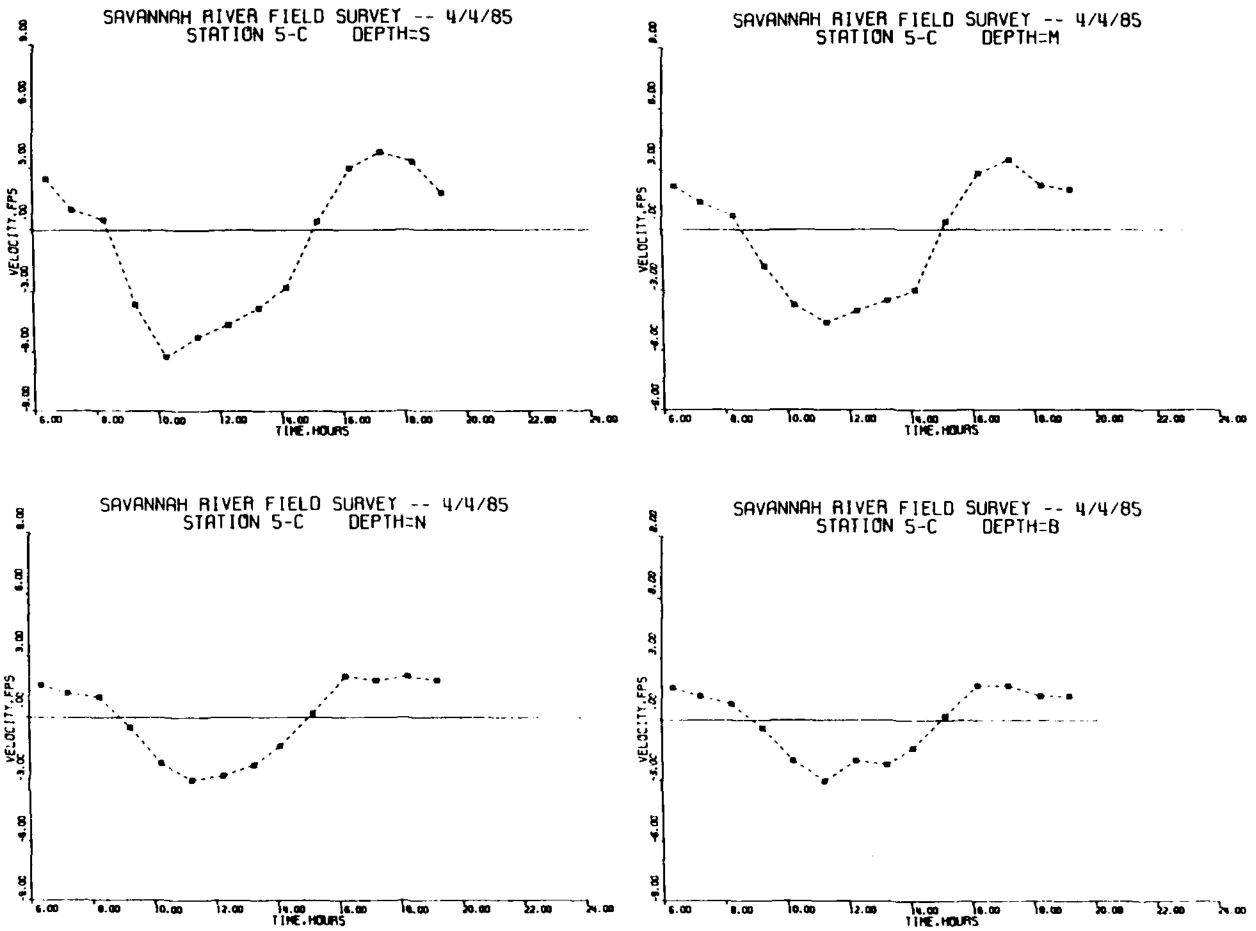


Figure B15. Velocity at sta 5 on right prism line

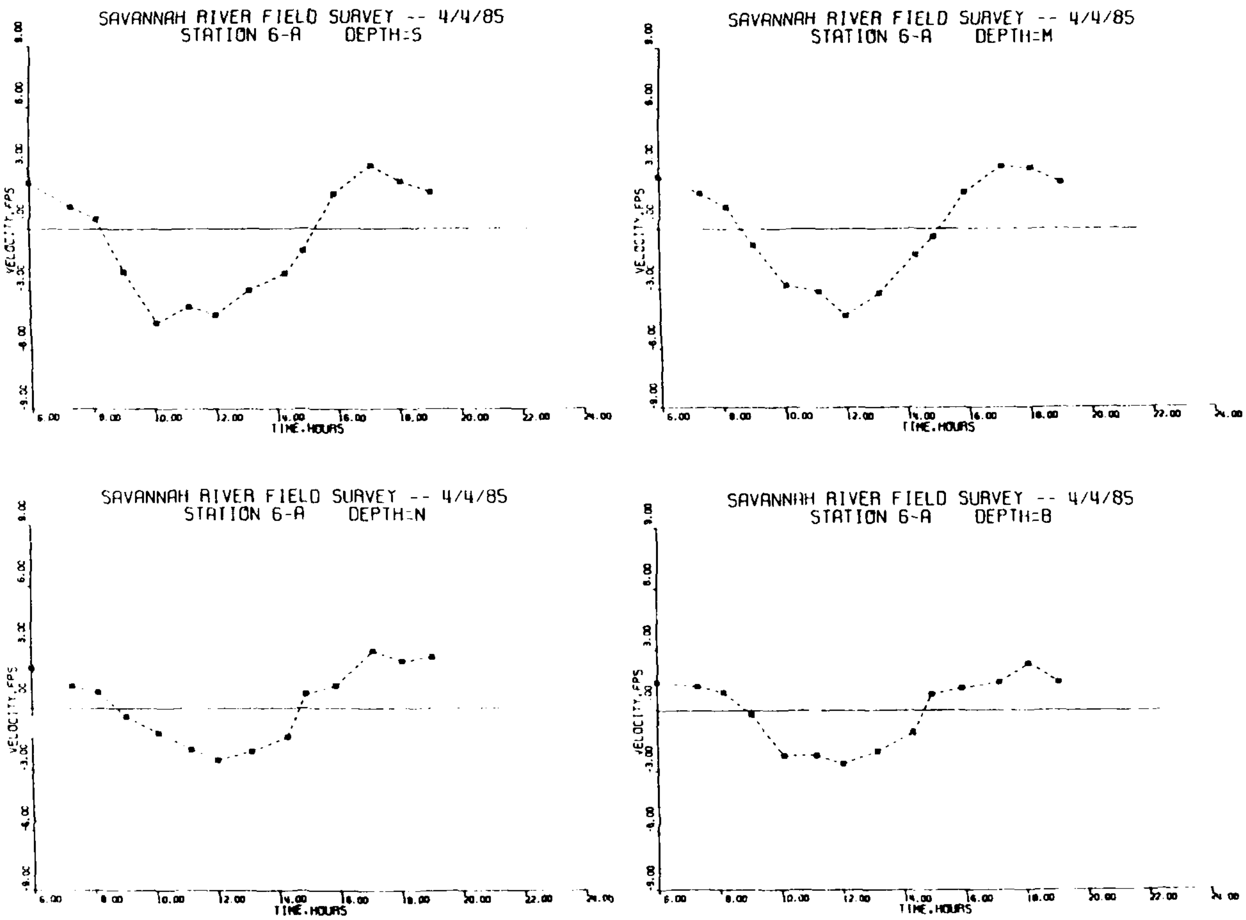


Figure B16. Velocity at sta 6 on left prism line

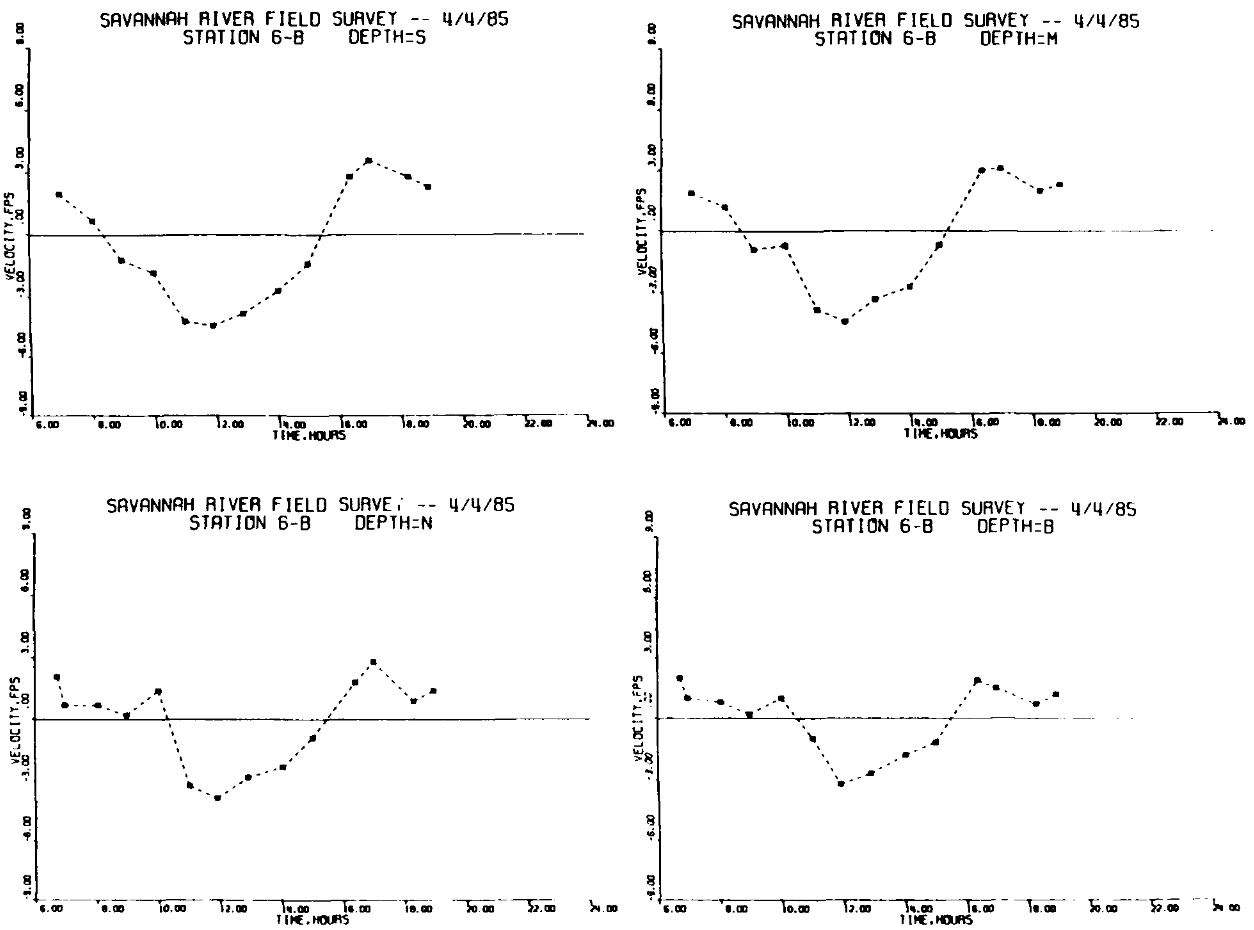


Figure B17. Velocity at sta 6 in center of channel

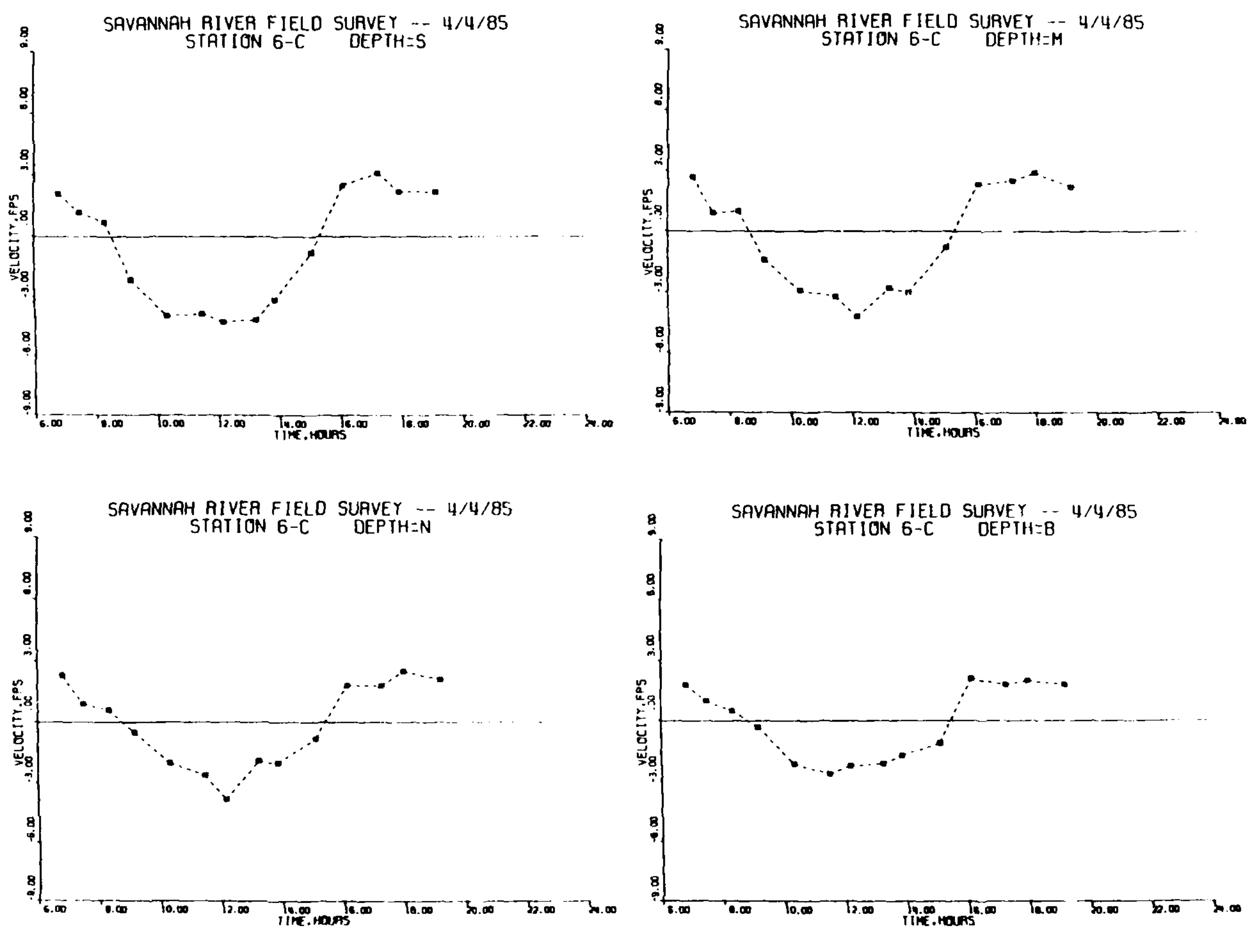


Figure B18. Velocity at sta 6 on right prism line

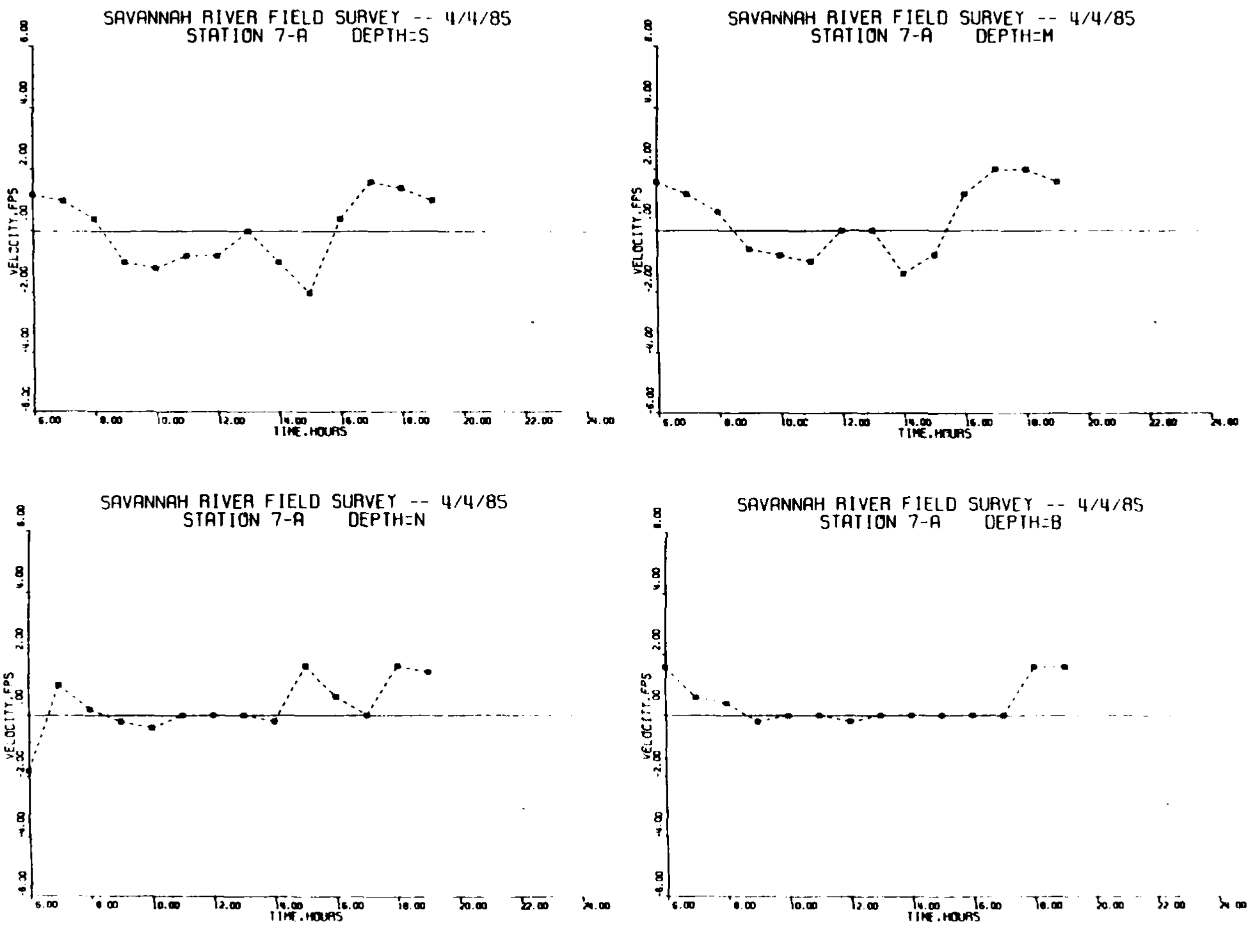


Figure B19. Velocity at sta 7 on left prism line

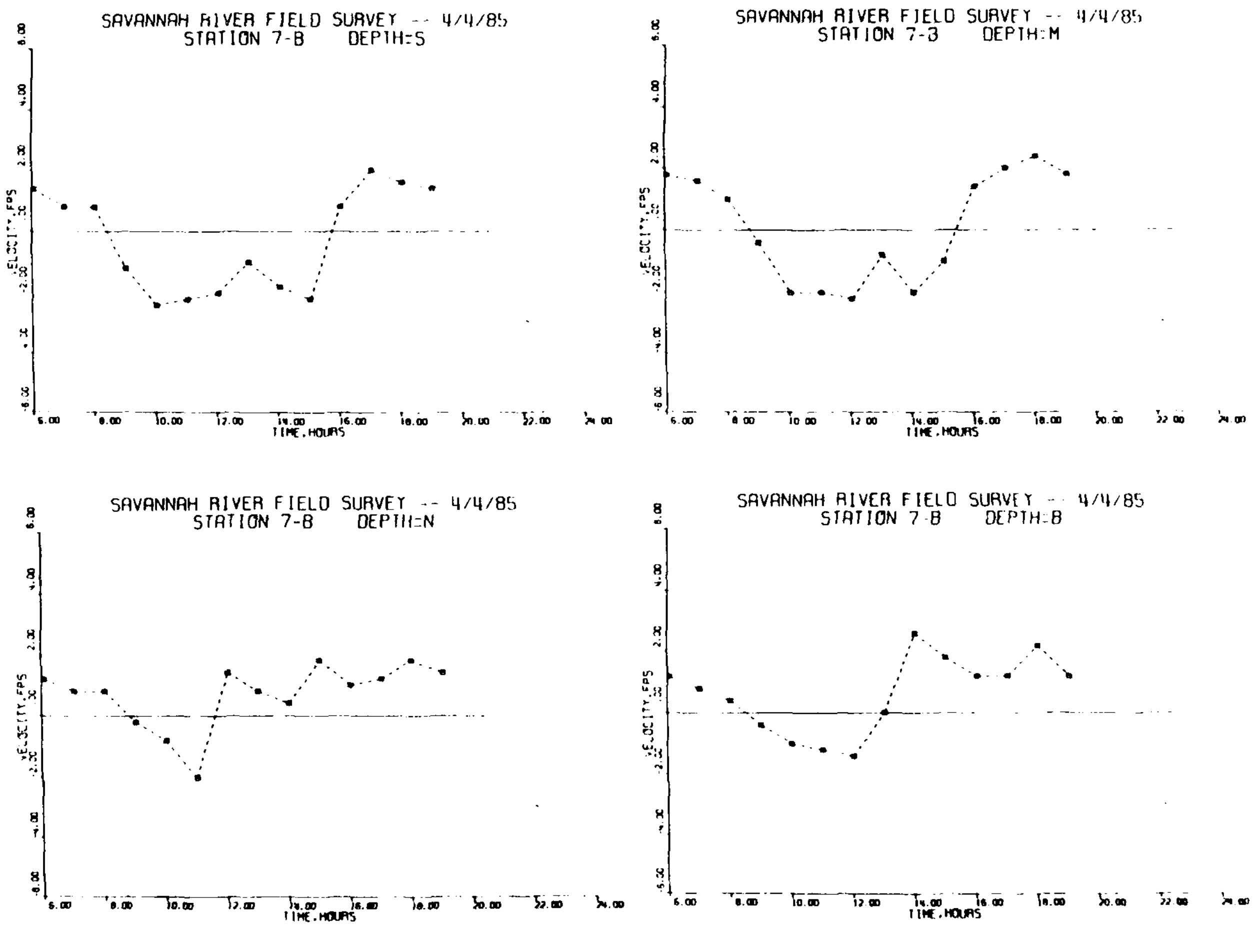


Figure B20. Velocity at sta 7 in center of channel

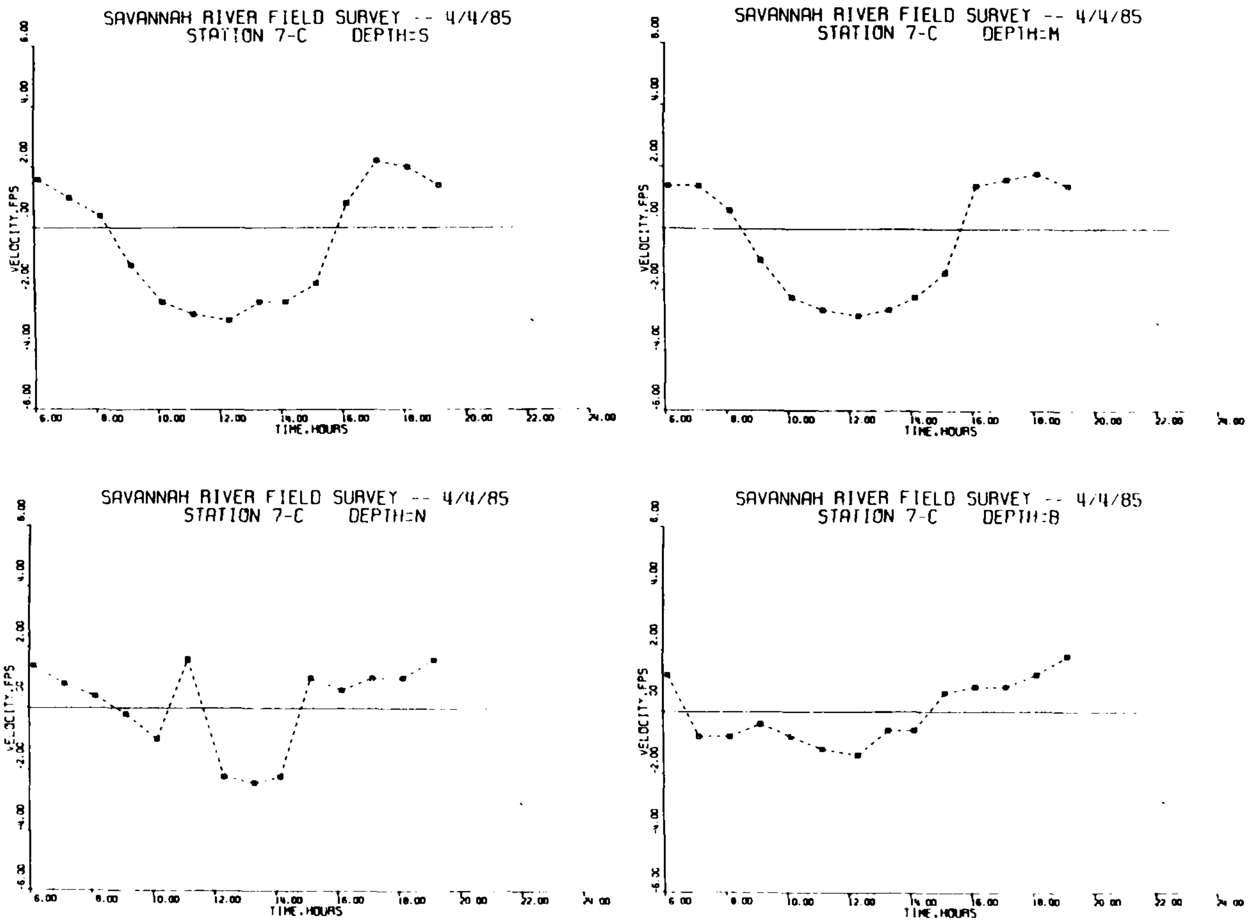


Figure B21. Velocity at sta 7 on right center line

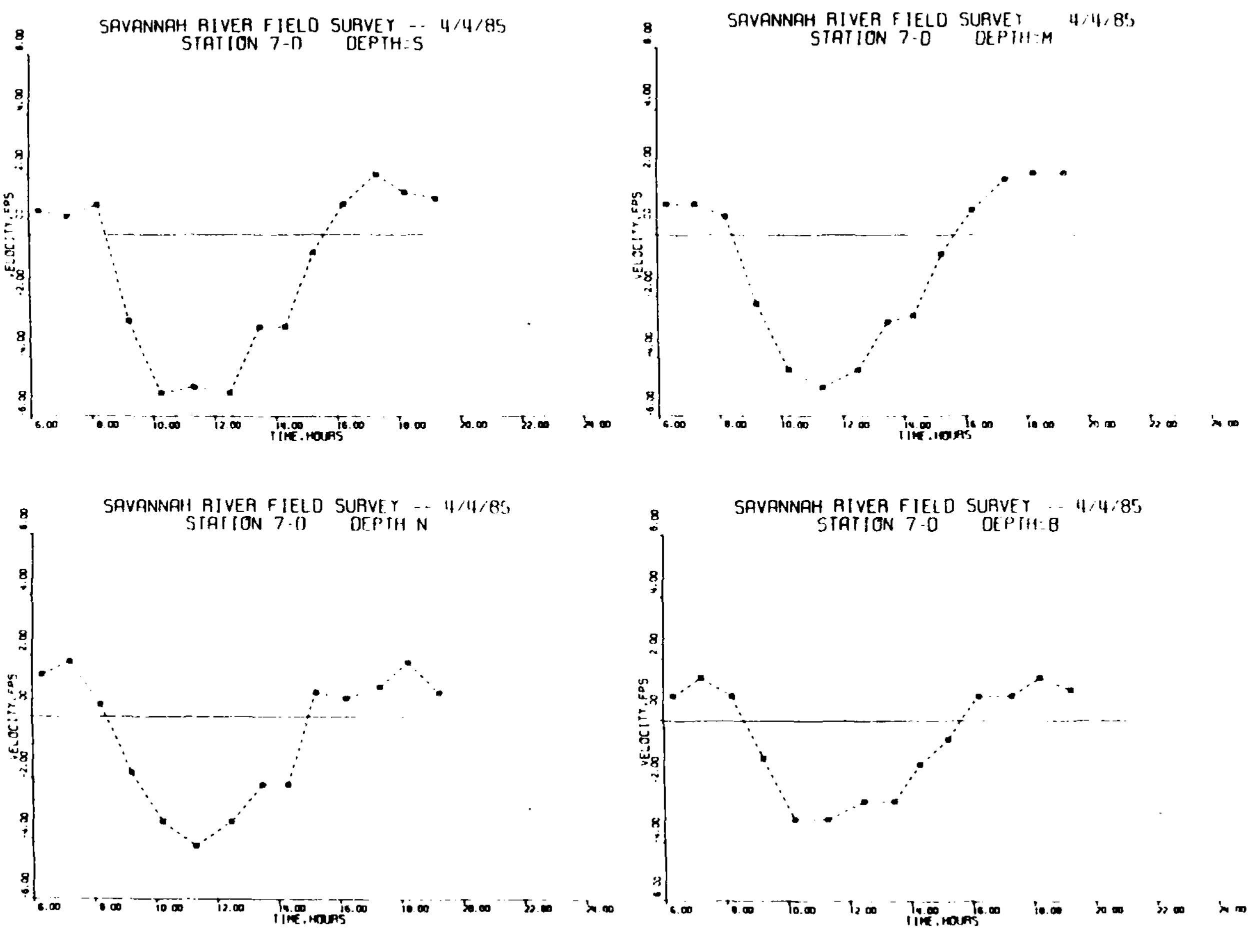


Figure B22. Velocity at sta 7 in Middle River on left prism line

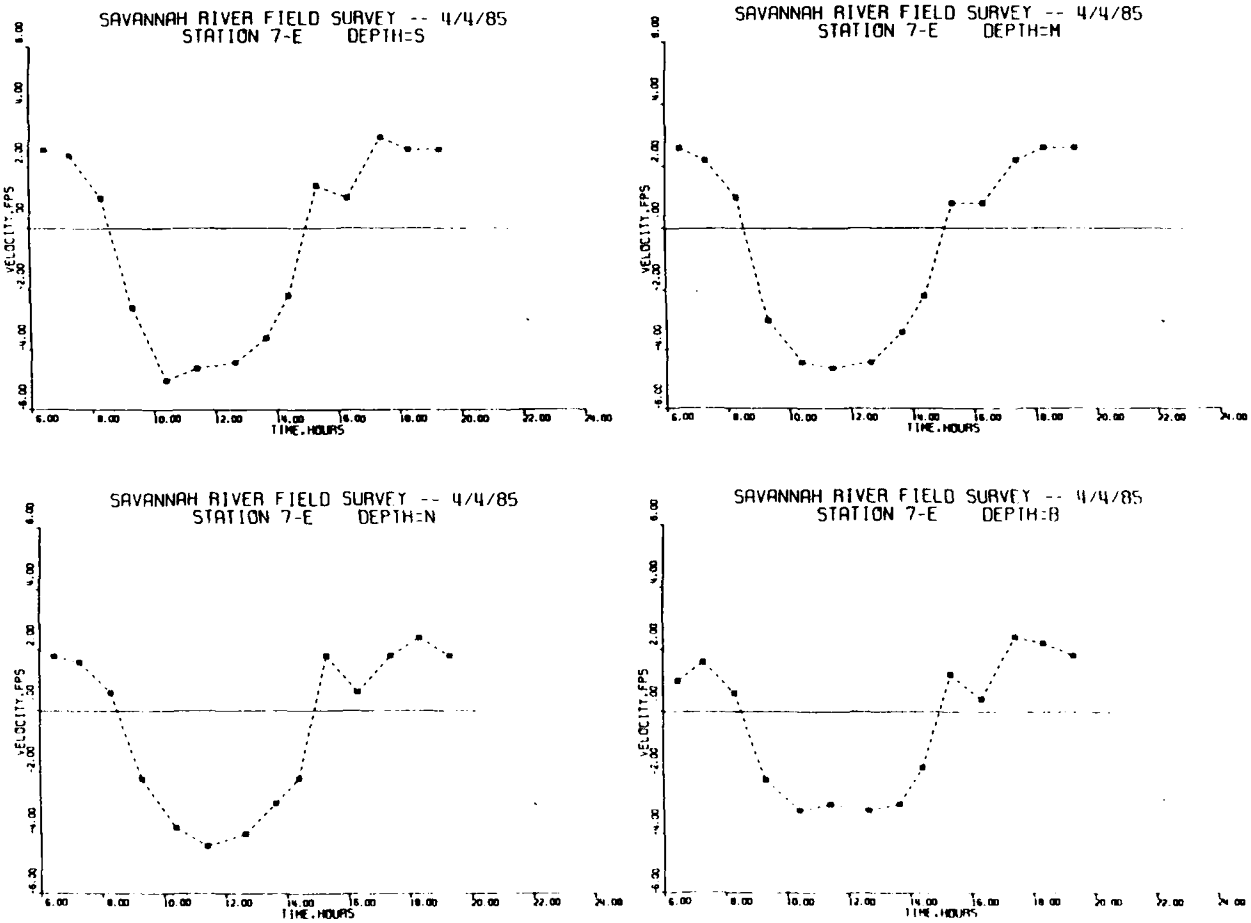


Figure B23. Velocity at sta 7 in Middle River on right prism line

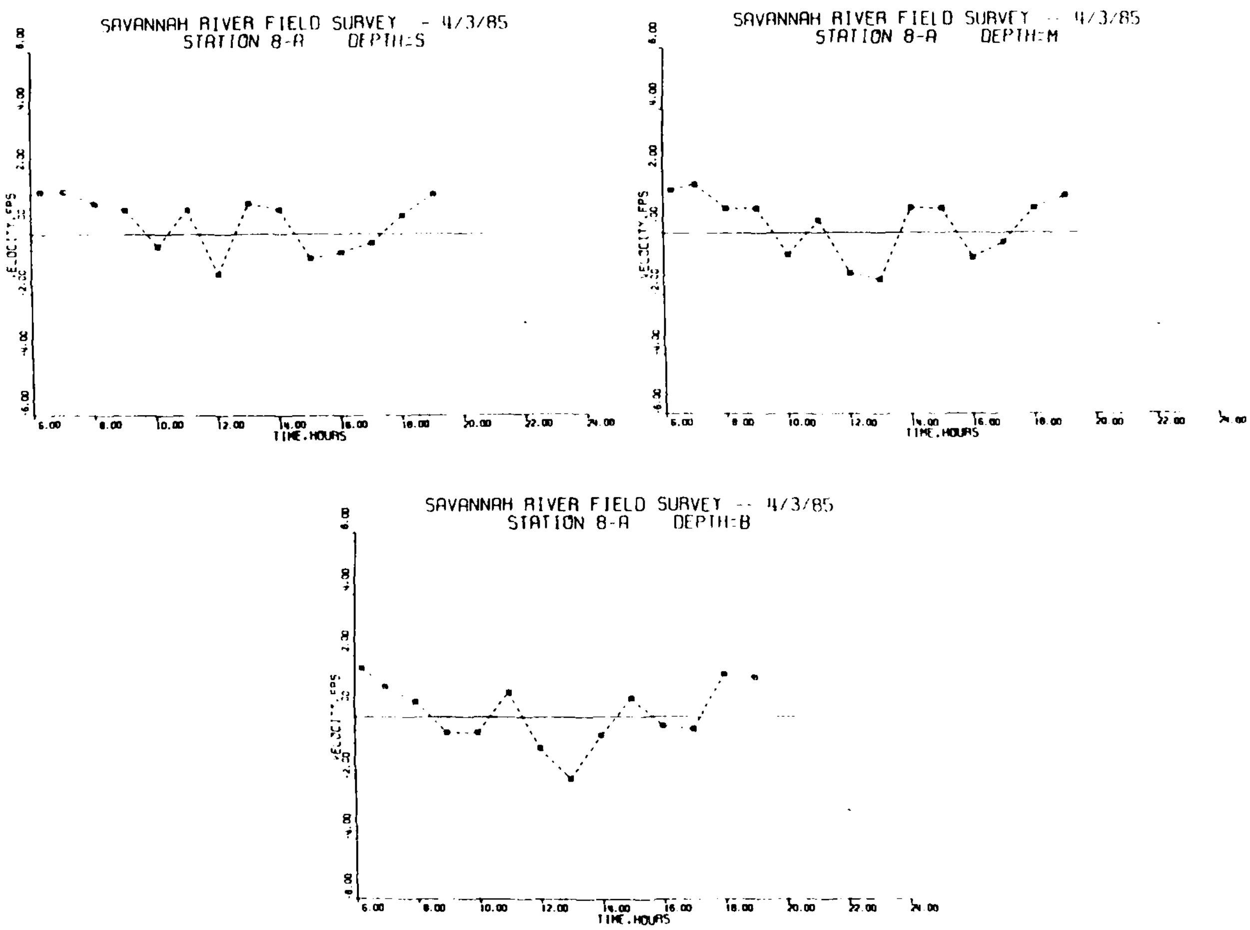


Figure B24. Velocity at sta 8 on left prism line

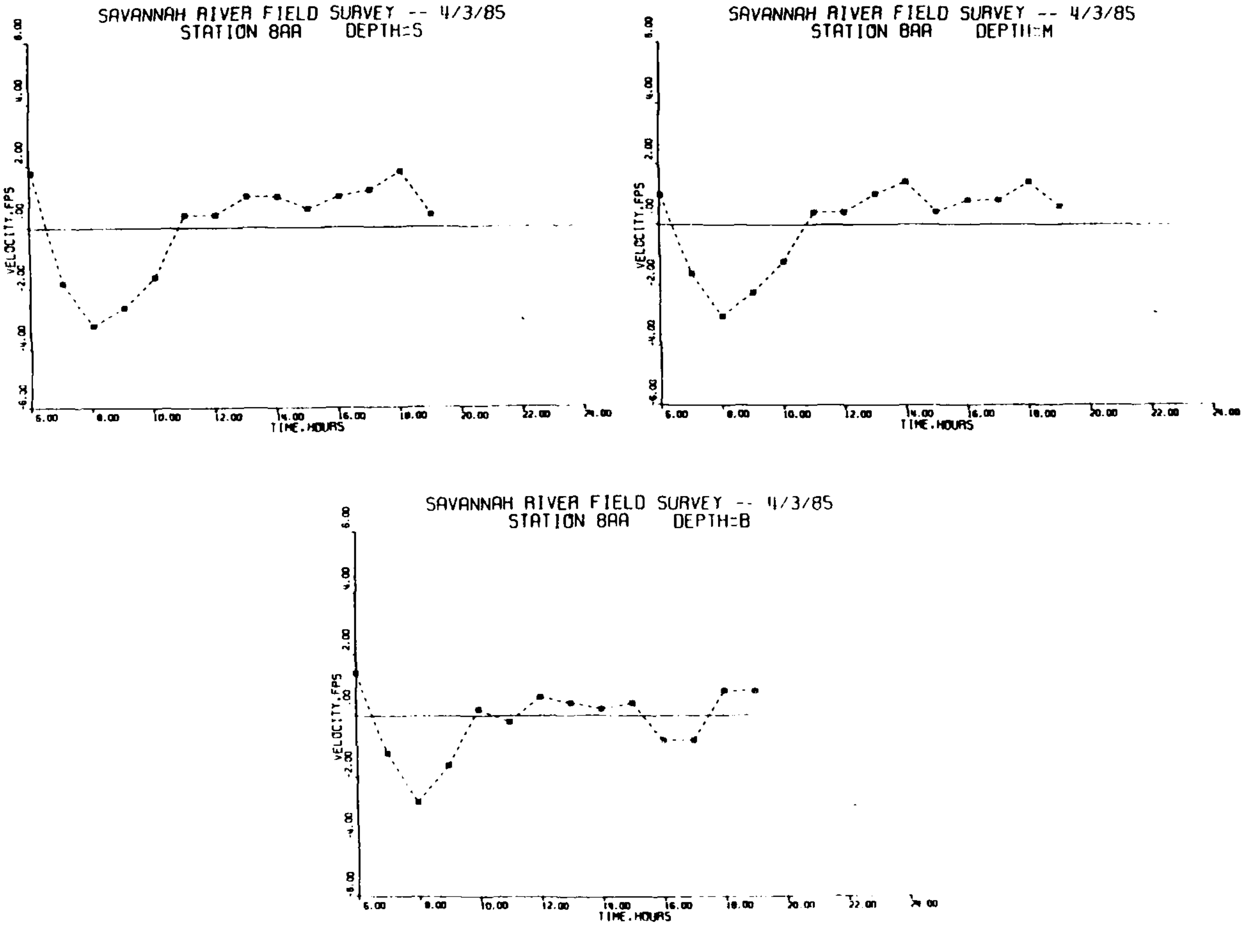


Figure B25. Velocity at sta 8 in center of channel

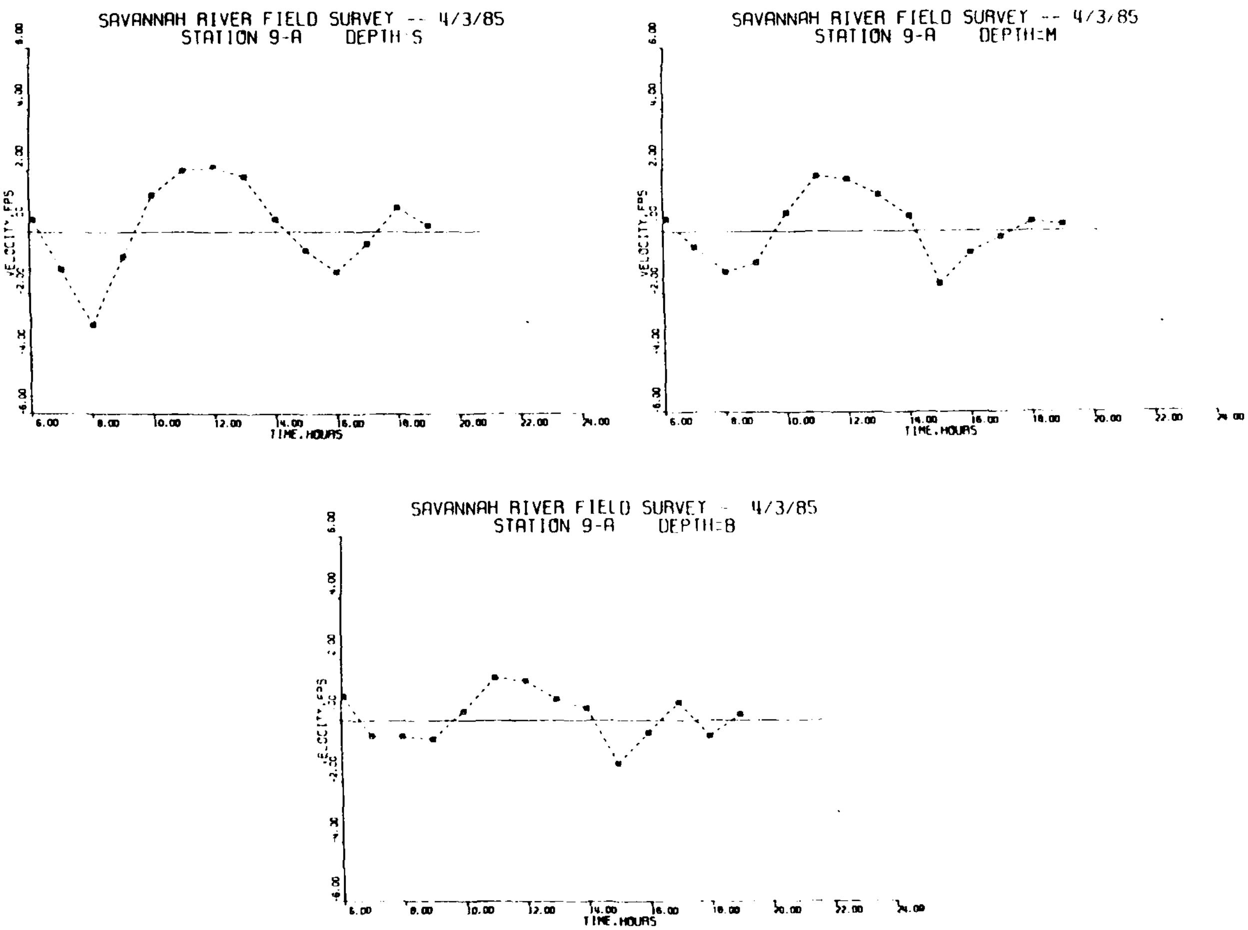


Figure B26. Velocity at sta 9 in center of channel

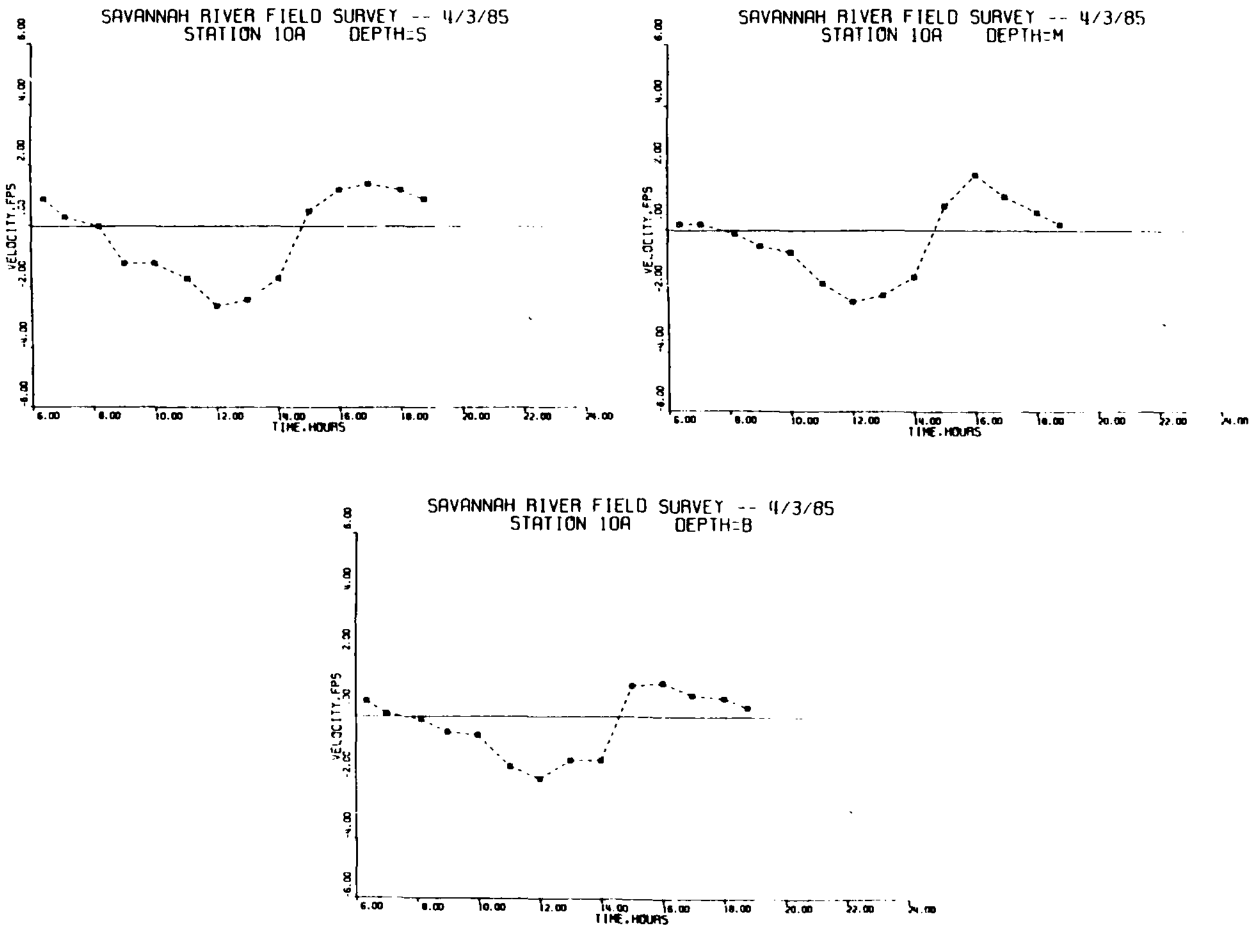


Figure B27. Velocity at sta 10 in center of channel

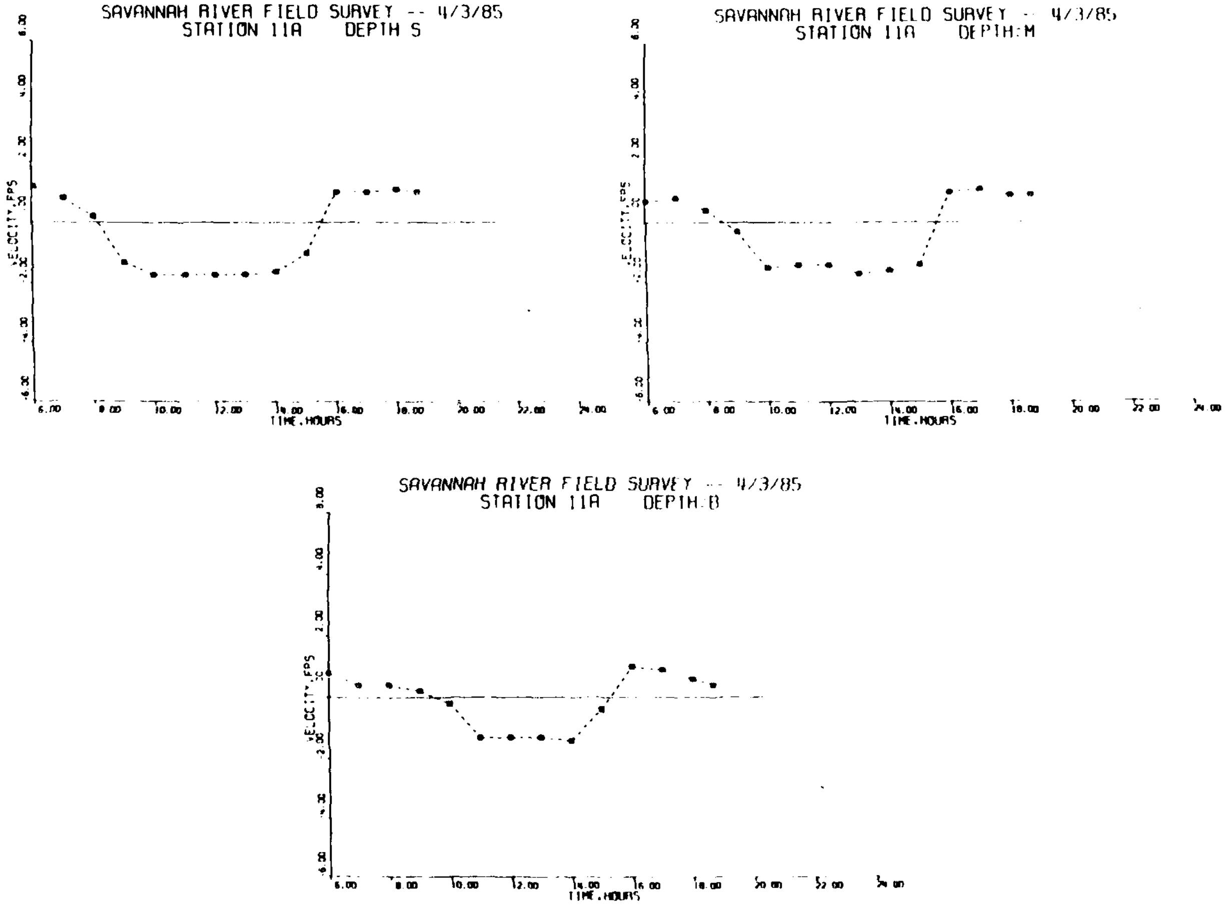


Figure B28. Velocity at sta 11 in center of channel

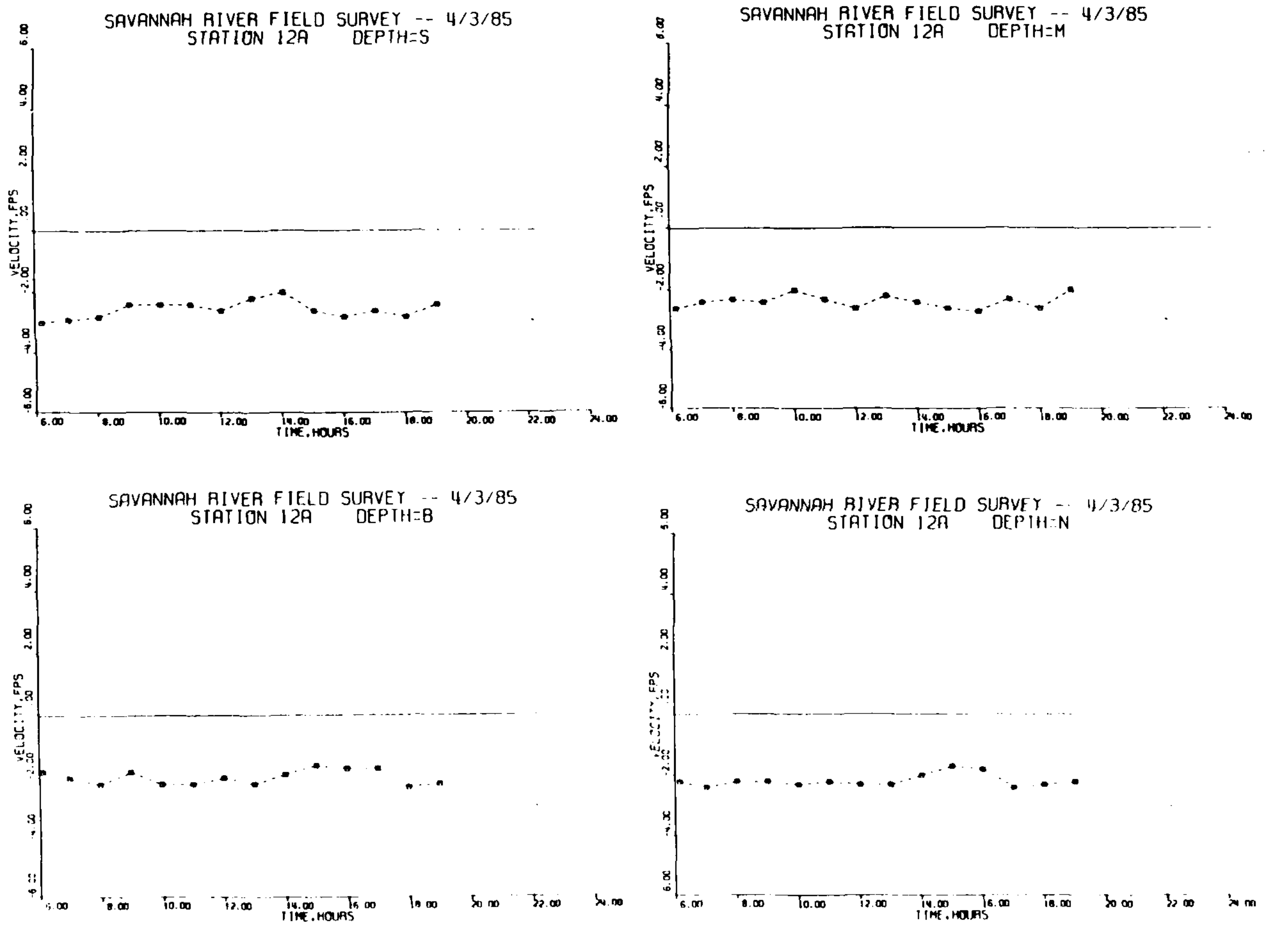


Figure B29. Velocity at sta 12 in center of channel

APPENDIX C: SALINITY DATA

Salinity data were collected at Ranges 8-12 on 3 April 1985 from 0600 to 1900 and at Ranges 1-7 on 4 April 1985 from 0600 to 1900. Measurements were taken at 1-hr intervals along the left (A) and right (C) channel prism line and in the center (B) of the channel at Ranges 1-6 and Range 7 in Front River. At Ranges 8-12, measurements were taken only in the center of the channel. Salinity plots are presented at the various ranges (labeled stations on the plots) in Figures C1-C29. The following notation is used to indicate the vertical location of the measurement:

S = Surface

1 = Two-thirds above the bottom

M = Middepth

2 = One-third above the bottom

N = 4 ft above bottom

B = 2 ft above bottom

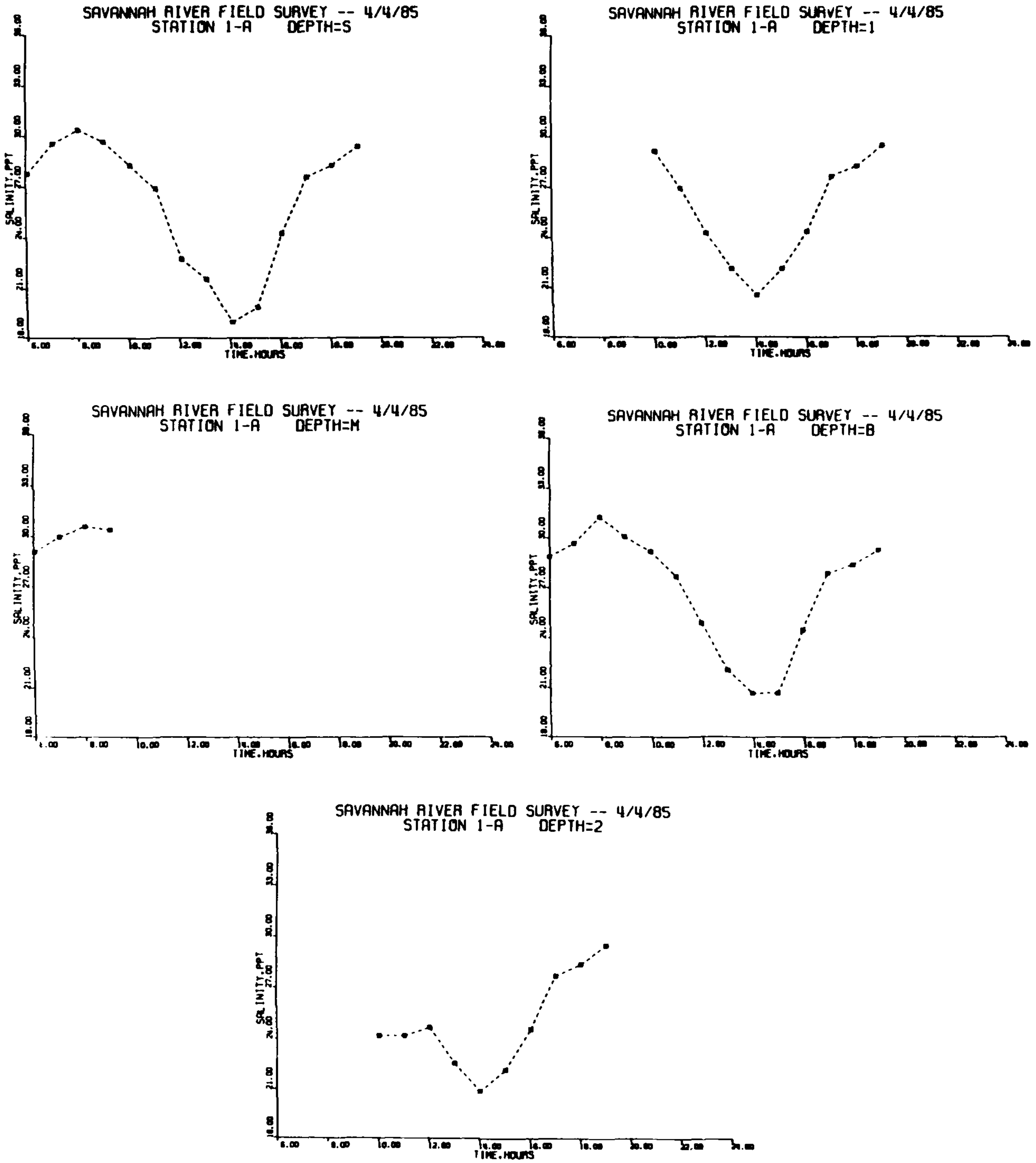


Figure C1. Salinity at Range 1 on left prism line

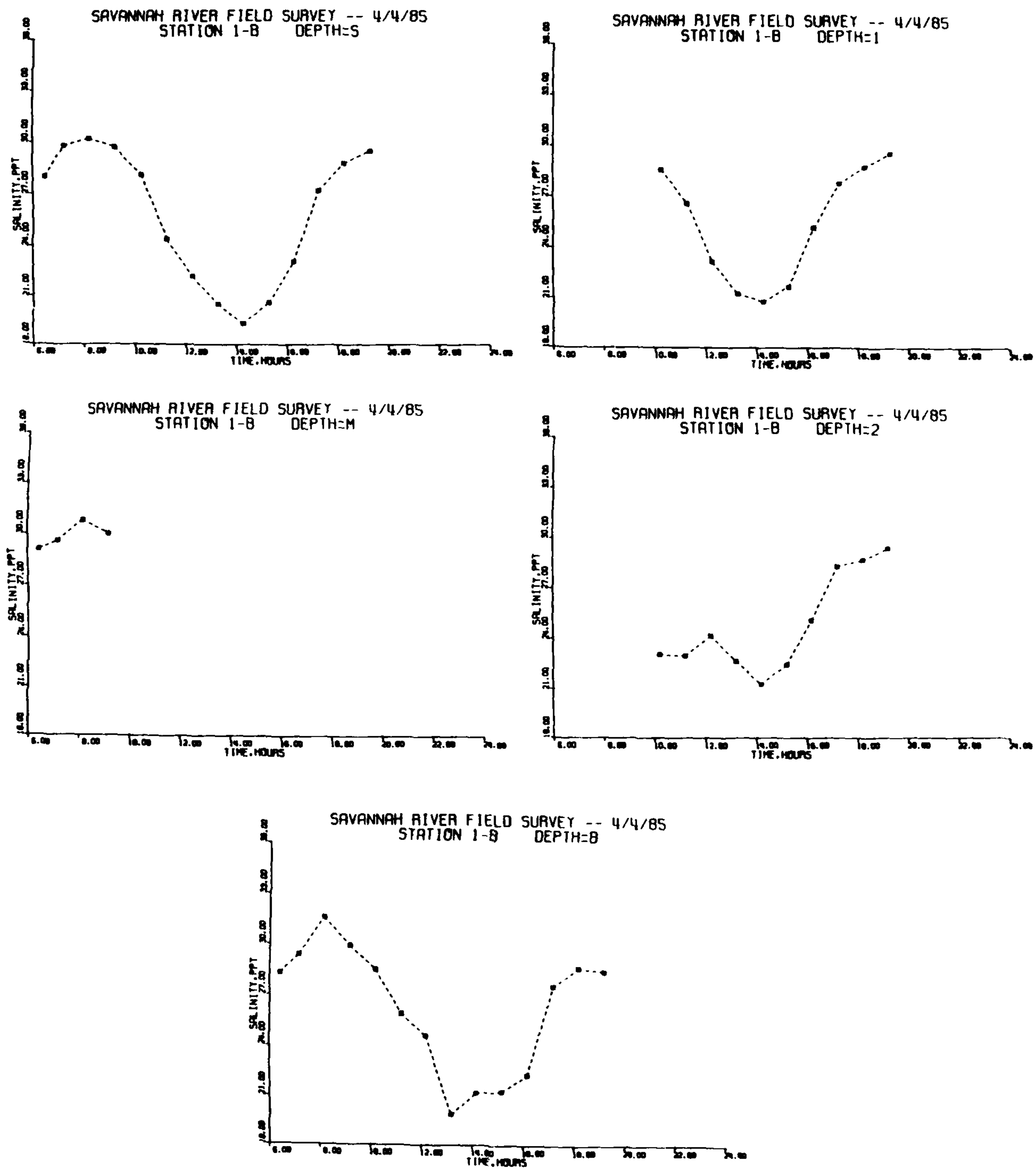


Figure C2. Salinity at Range 1 in center of channel.

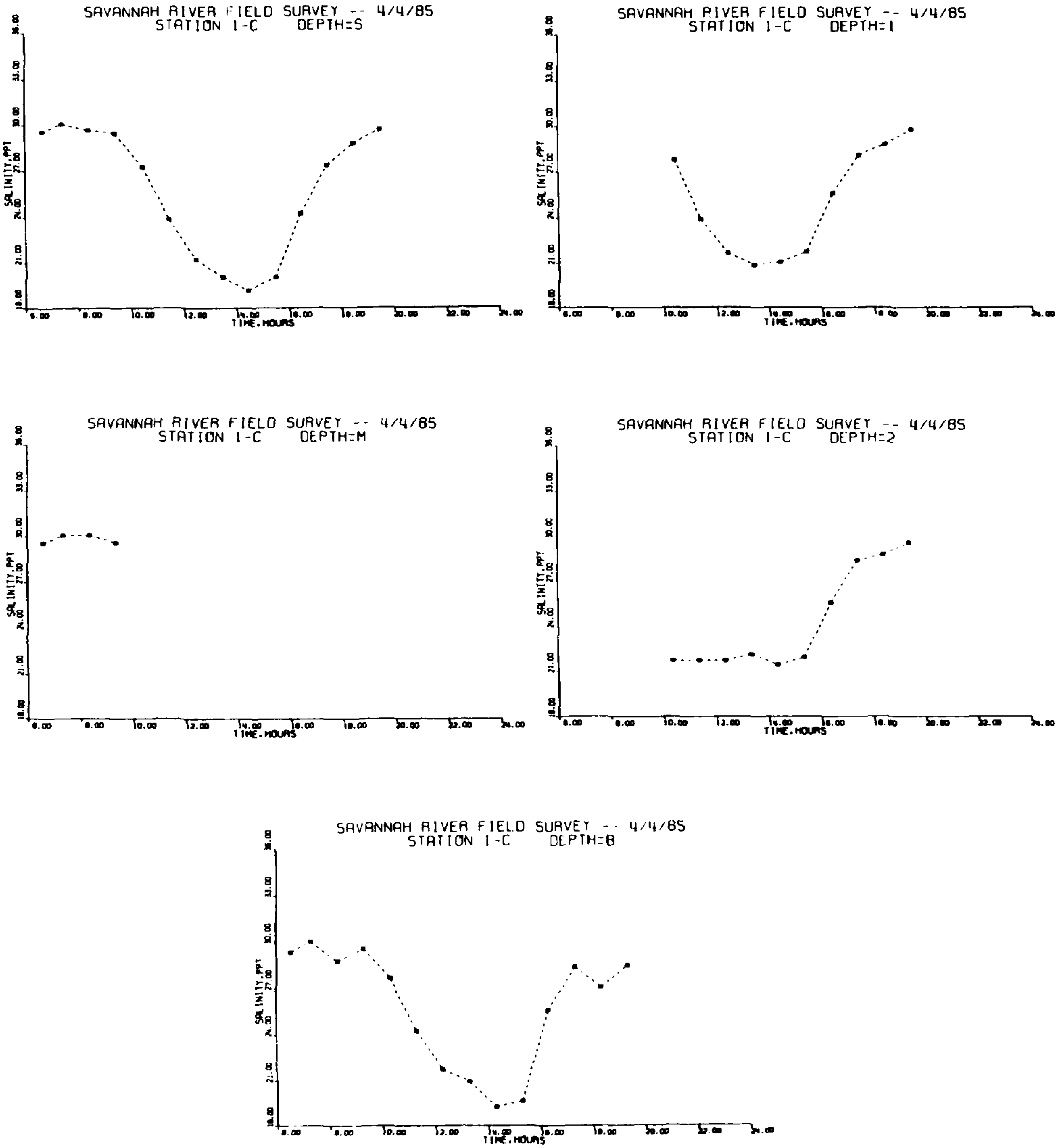


Figure C3. Salinity at Range 1 on right prism line

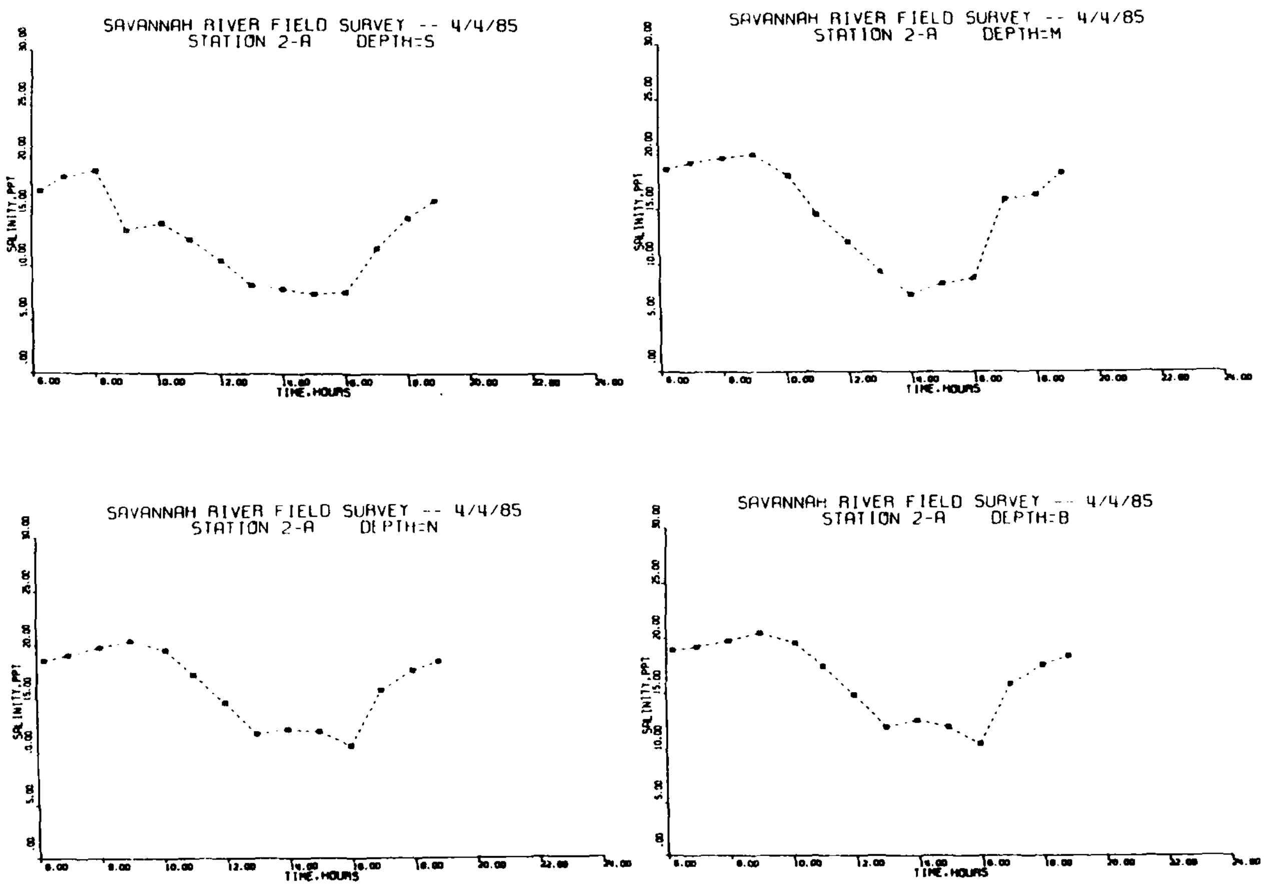


Figure C4. Salinity at Range 2 on left prism line

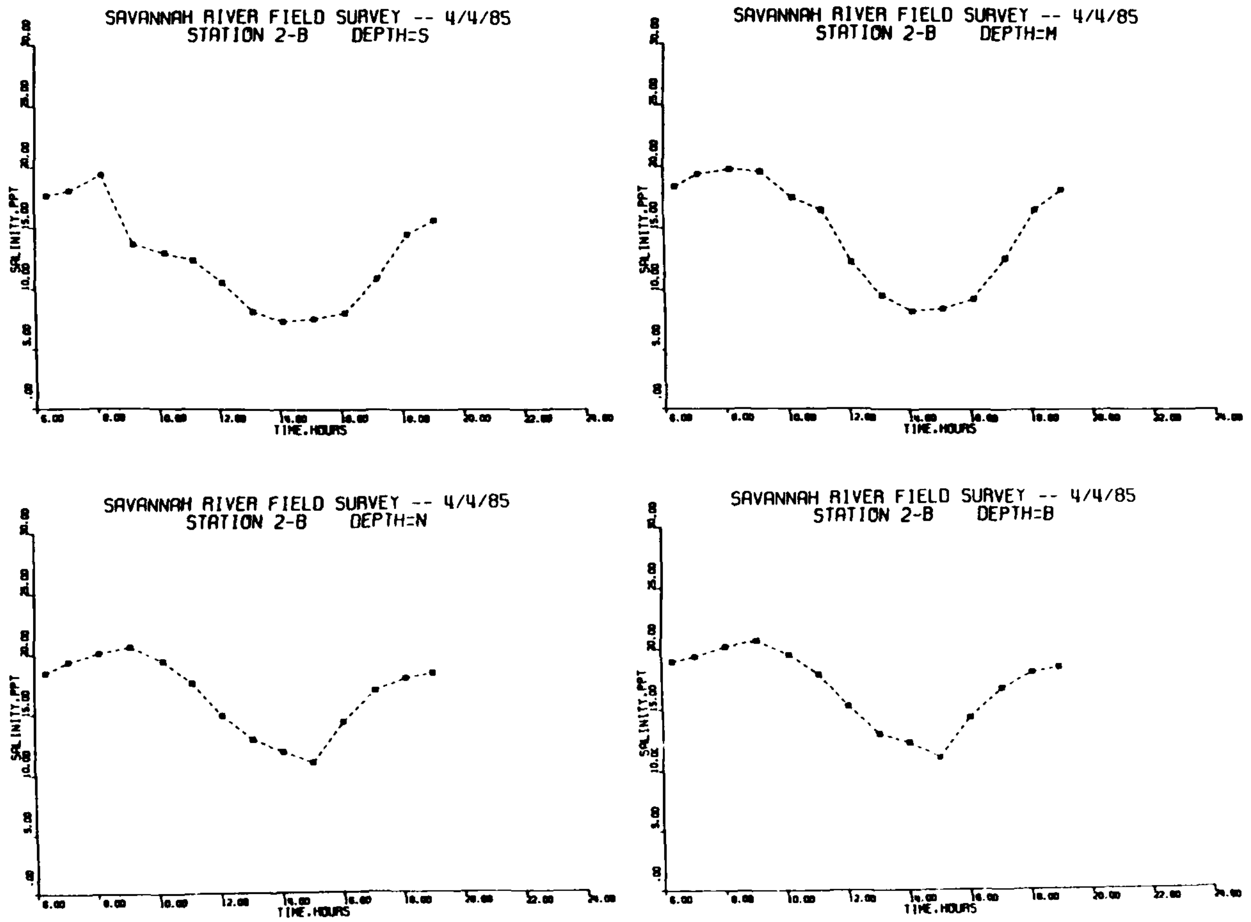


Figure C5. Salinity at Range 2 in center of channel

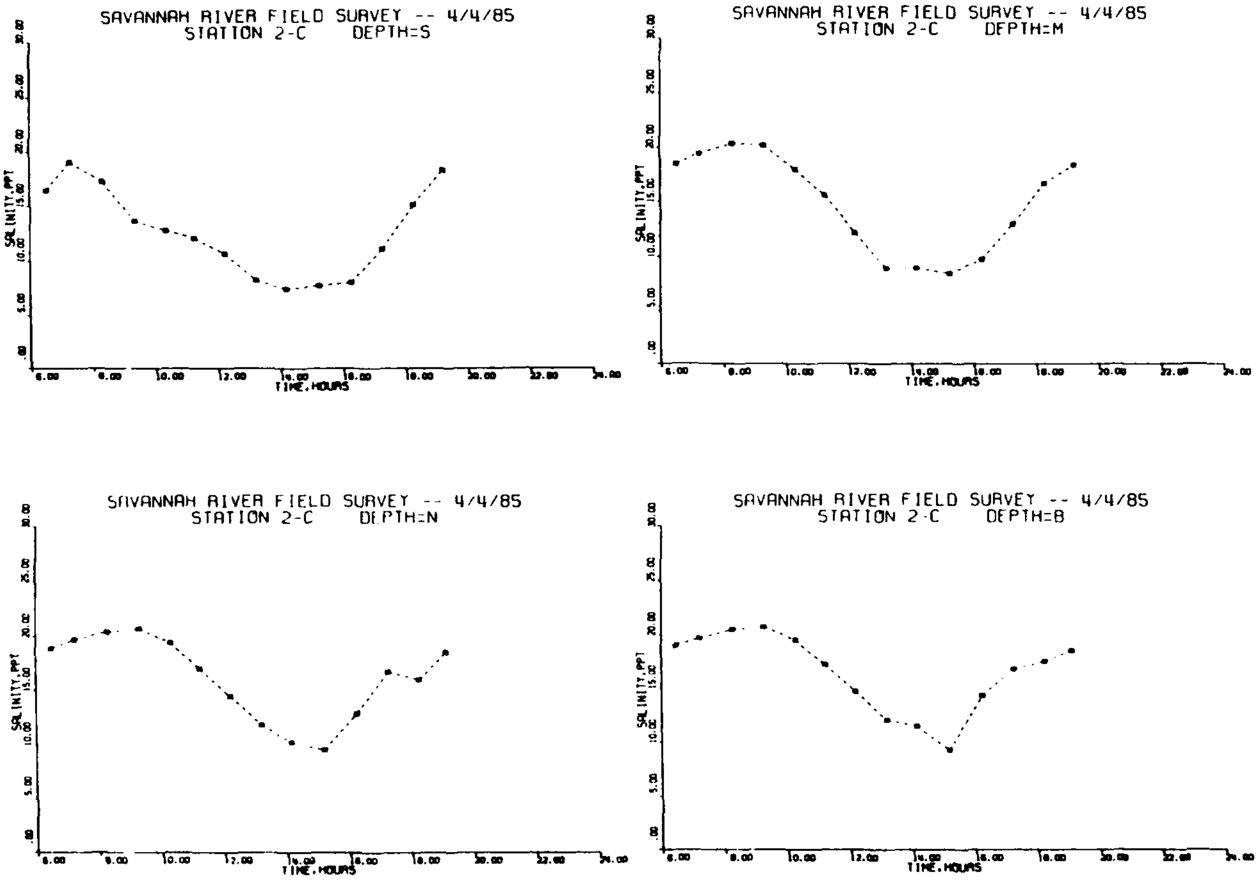


Figure C6. Salinity at Range 2 on right prism line

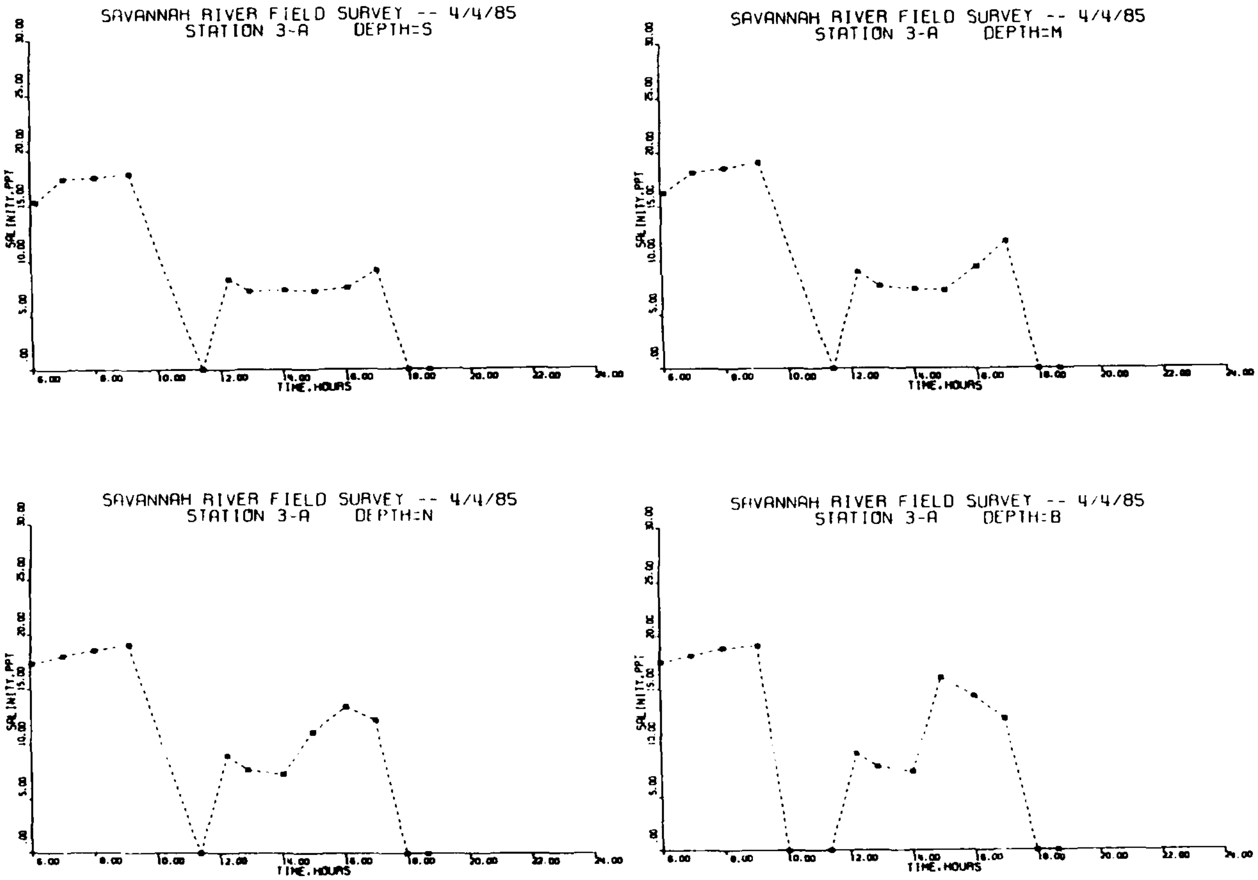


Figure C7. Salinity at Range 3 on left prism line

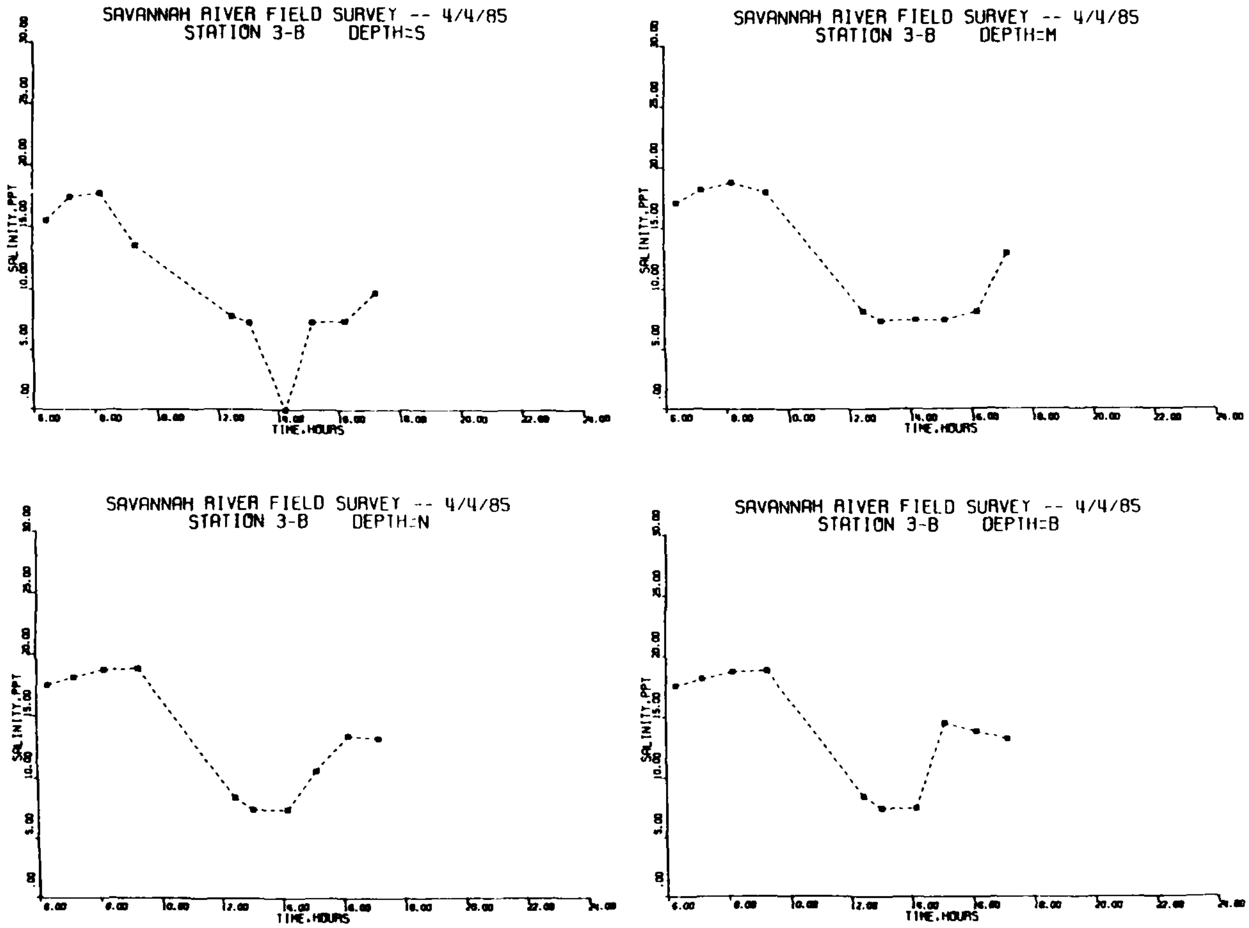


Figure C8. Salinity at Range 3 in center of channel

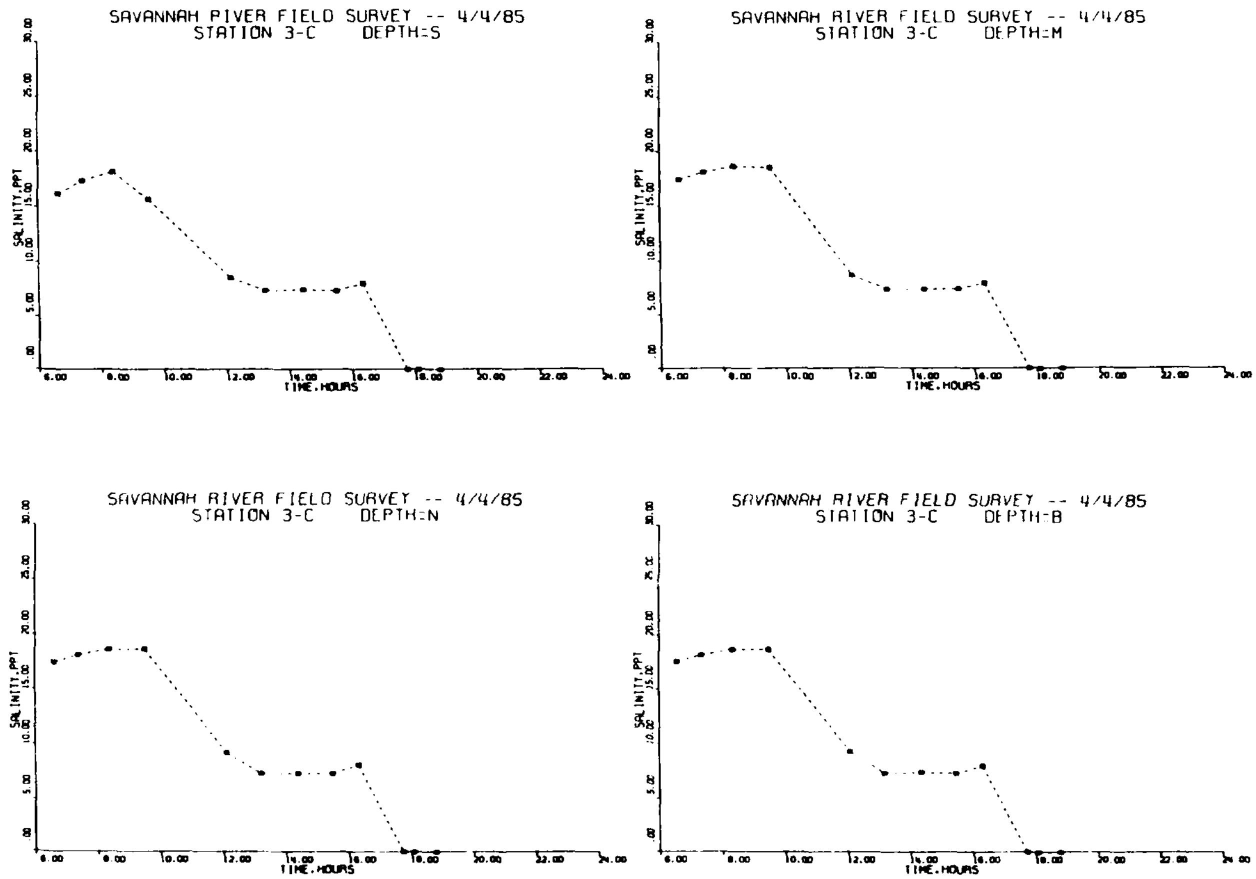


Figure C9. Salinity at Range 3 on right prism line

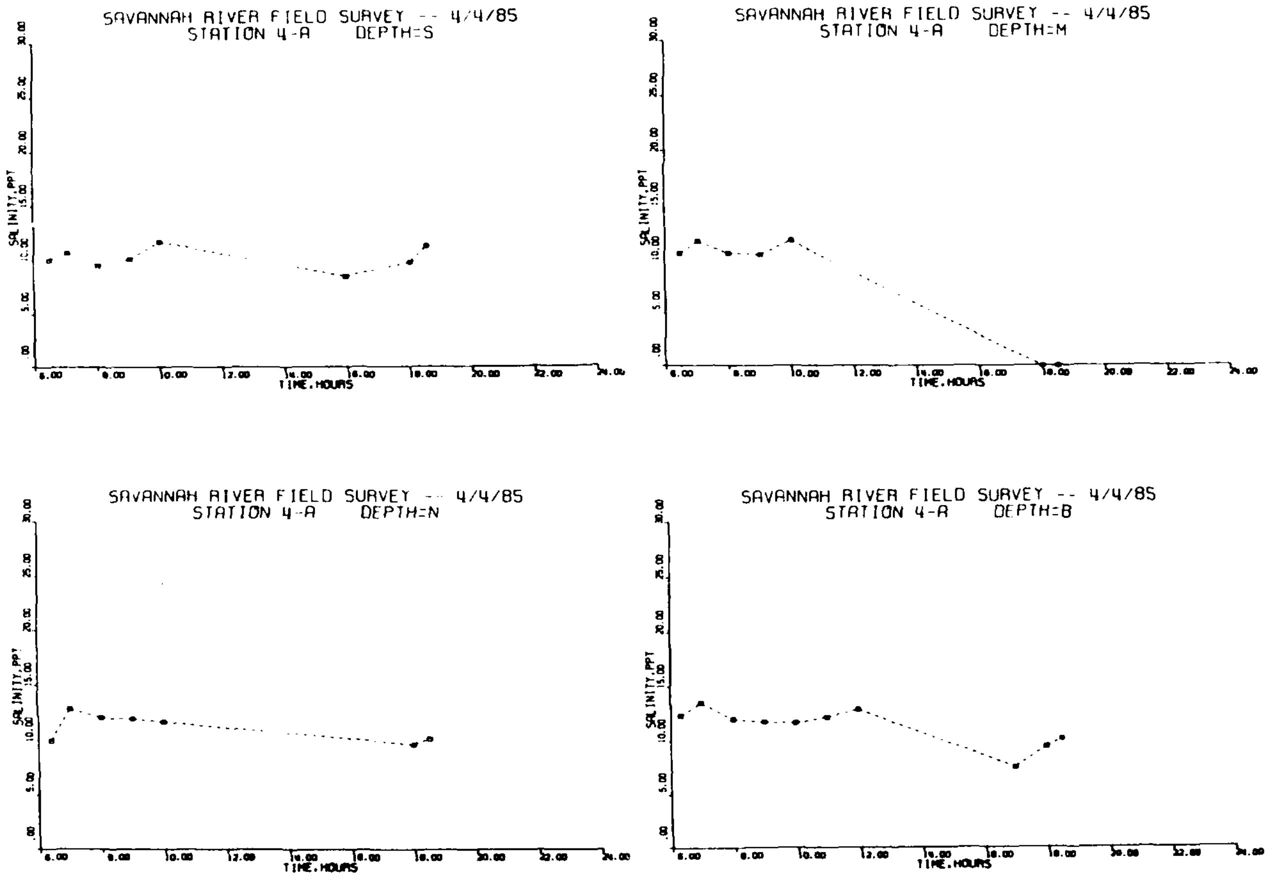


Figure C10. Salinity at Range 4 on left prism line

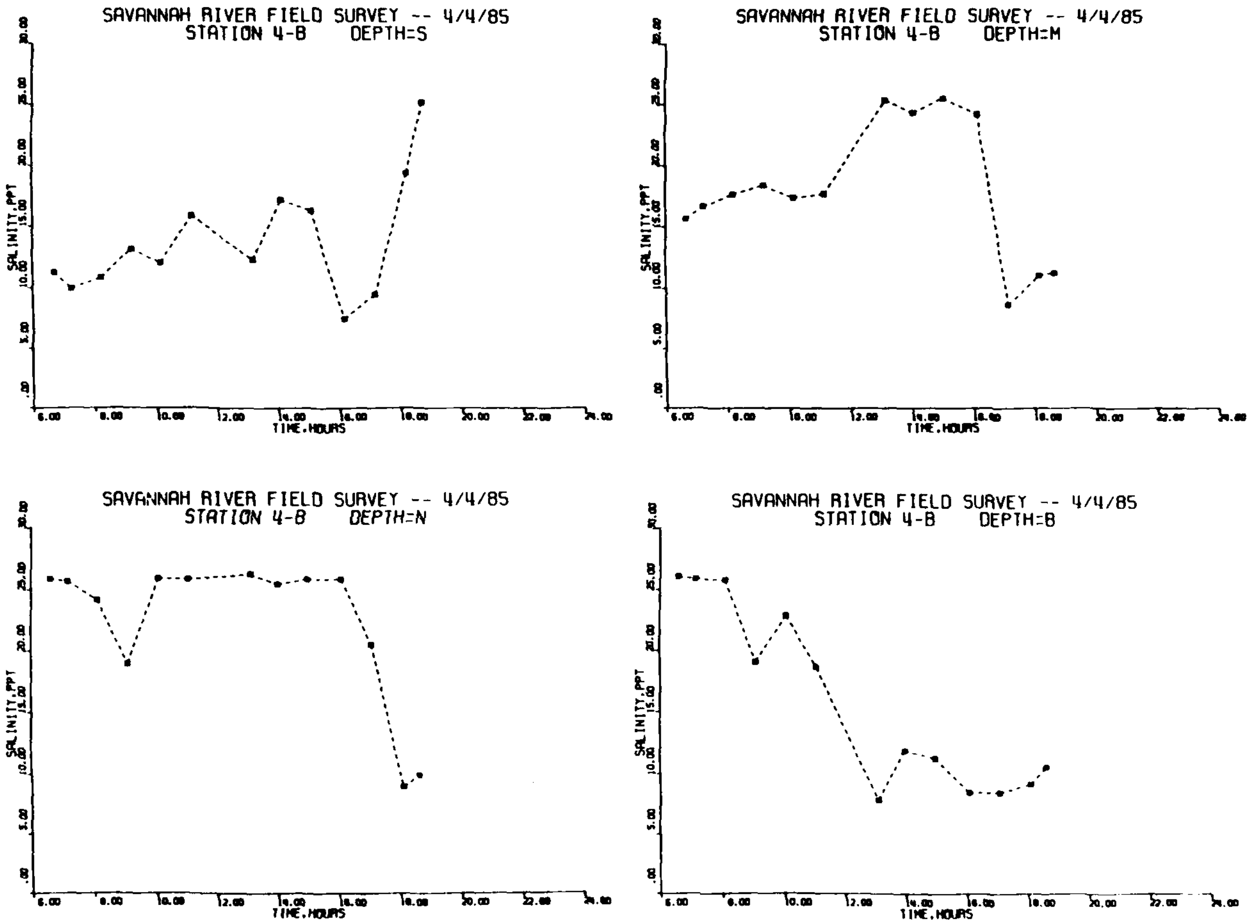


Figure C11. Salinity at Range 4 in center of channel

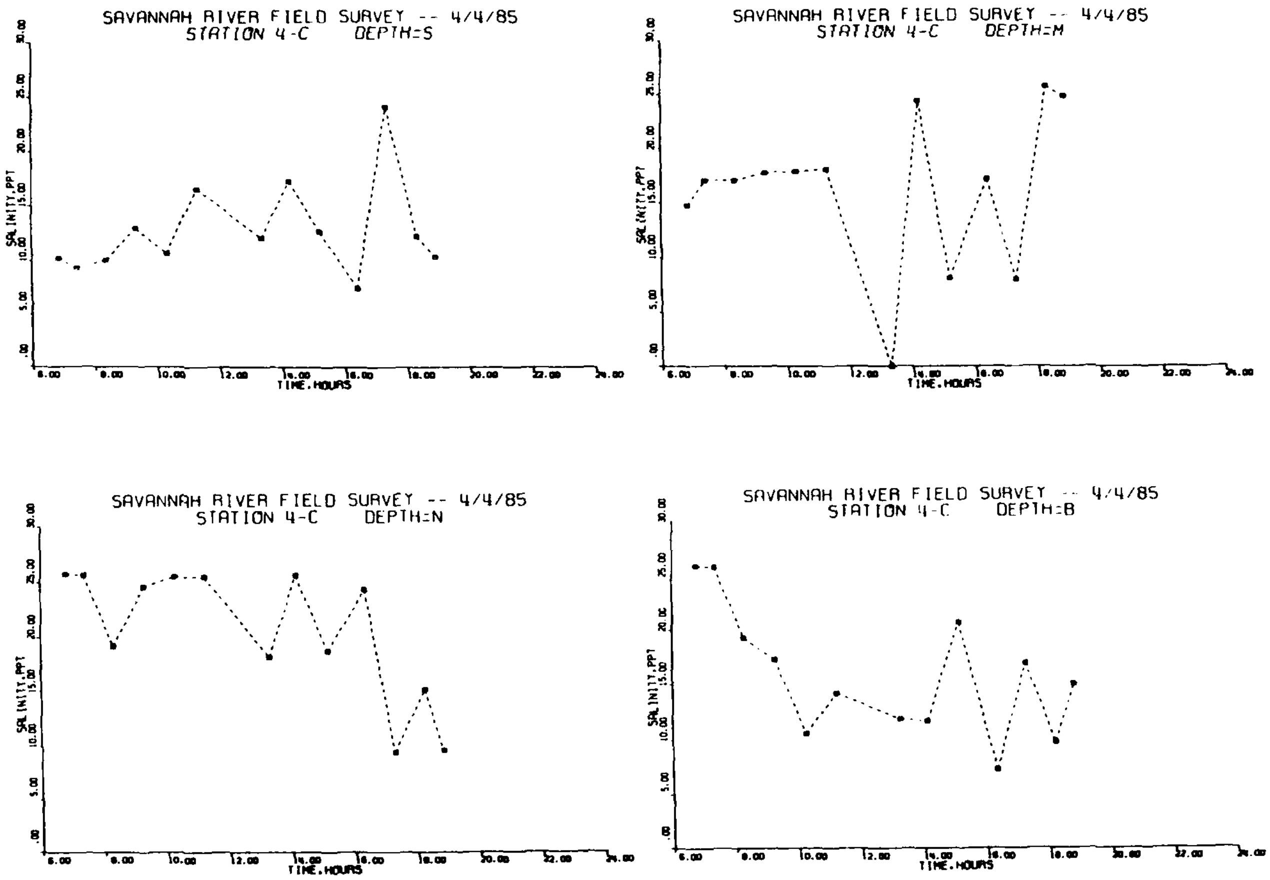


Figure C12. Salinity at Range 4 on right prism line

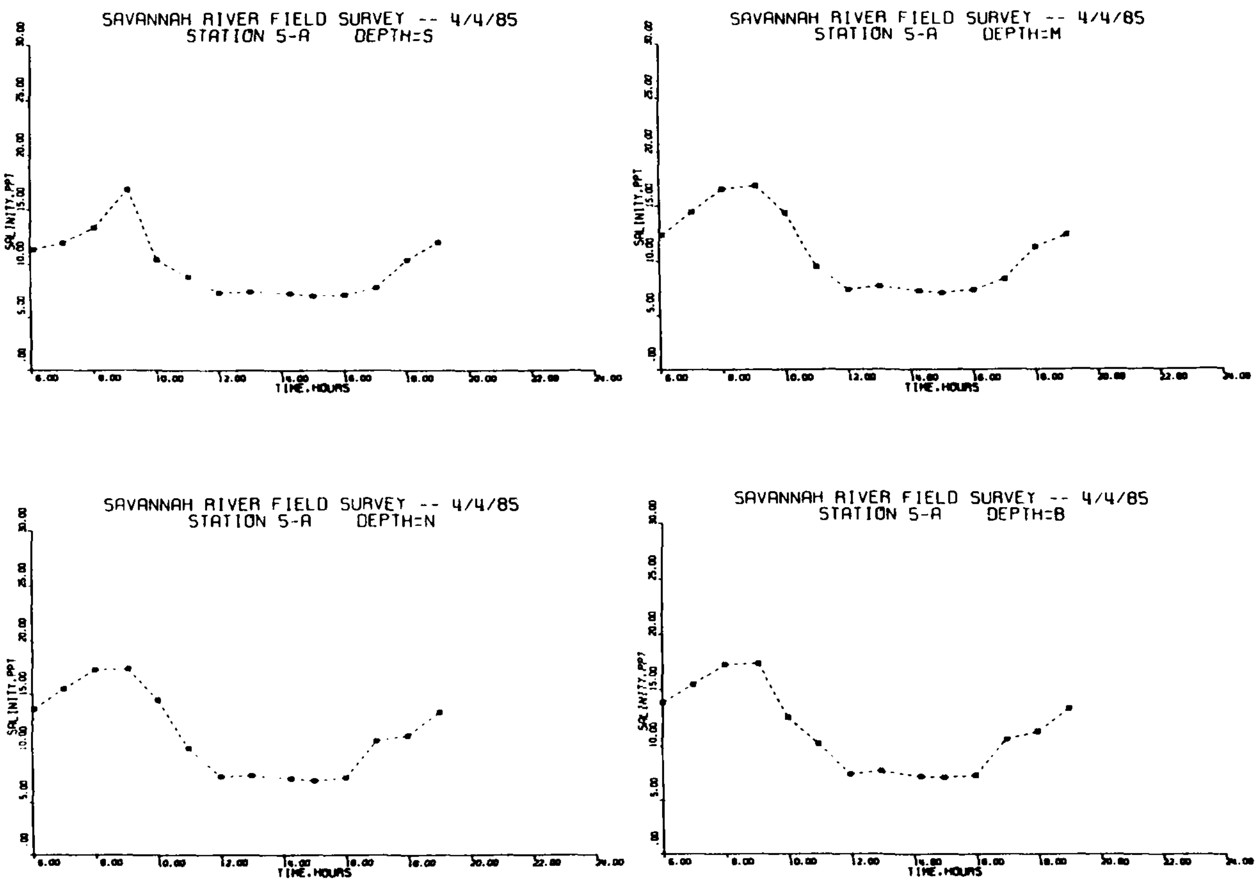


Figure C13. Salinity at Range 5 on left prism line

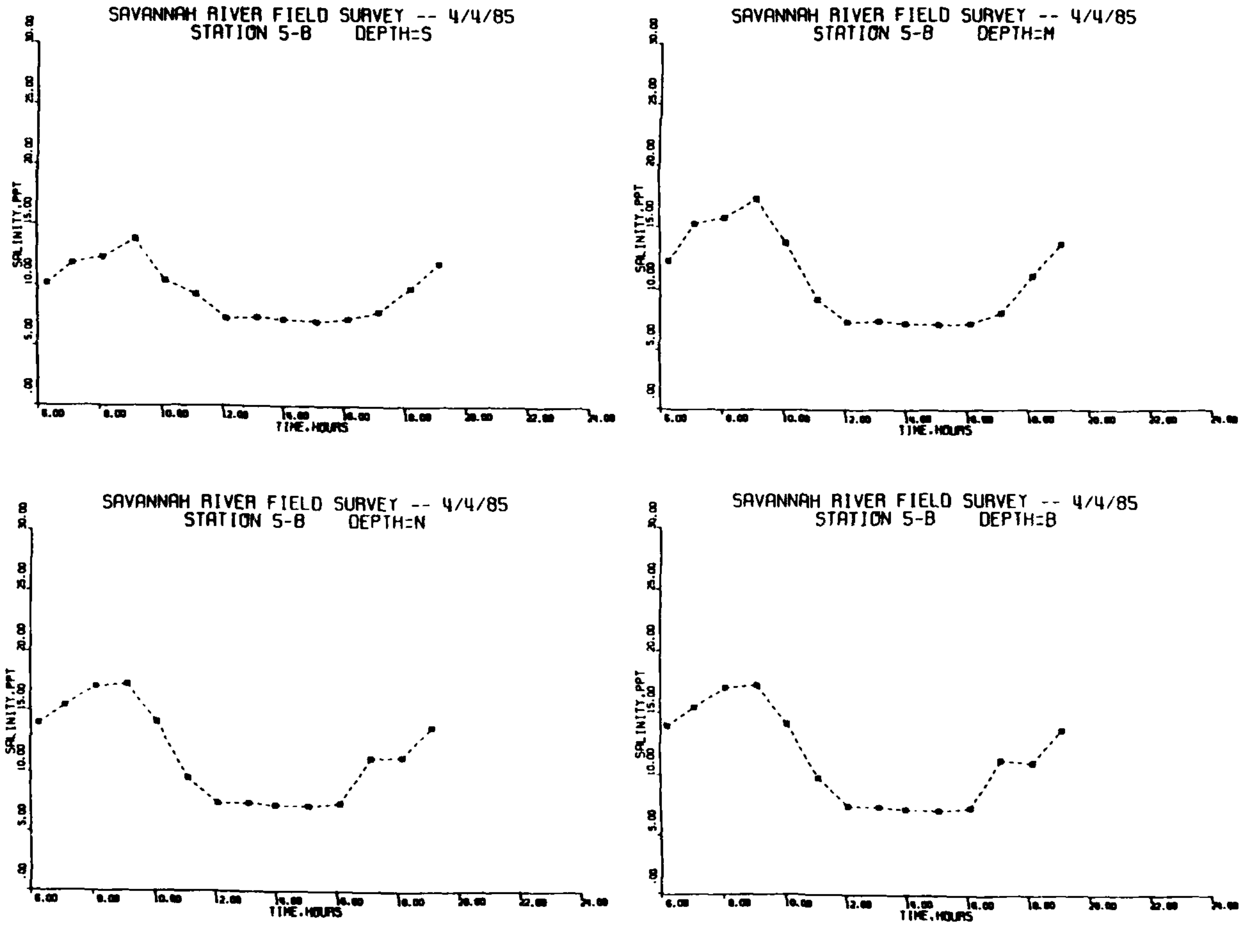


Figure C14. Salinity at Range 5 in center of channel

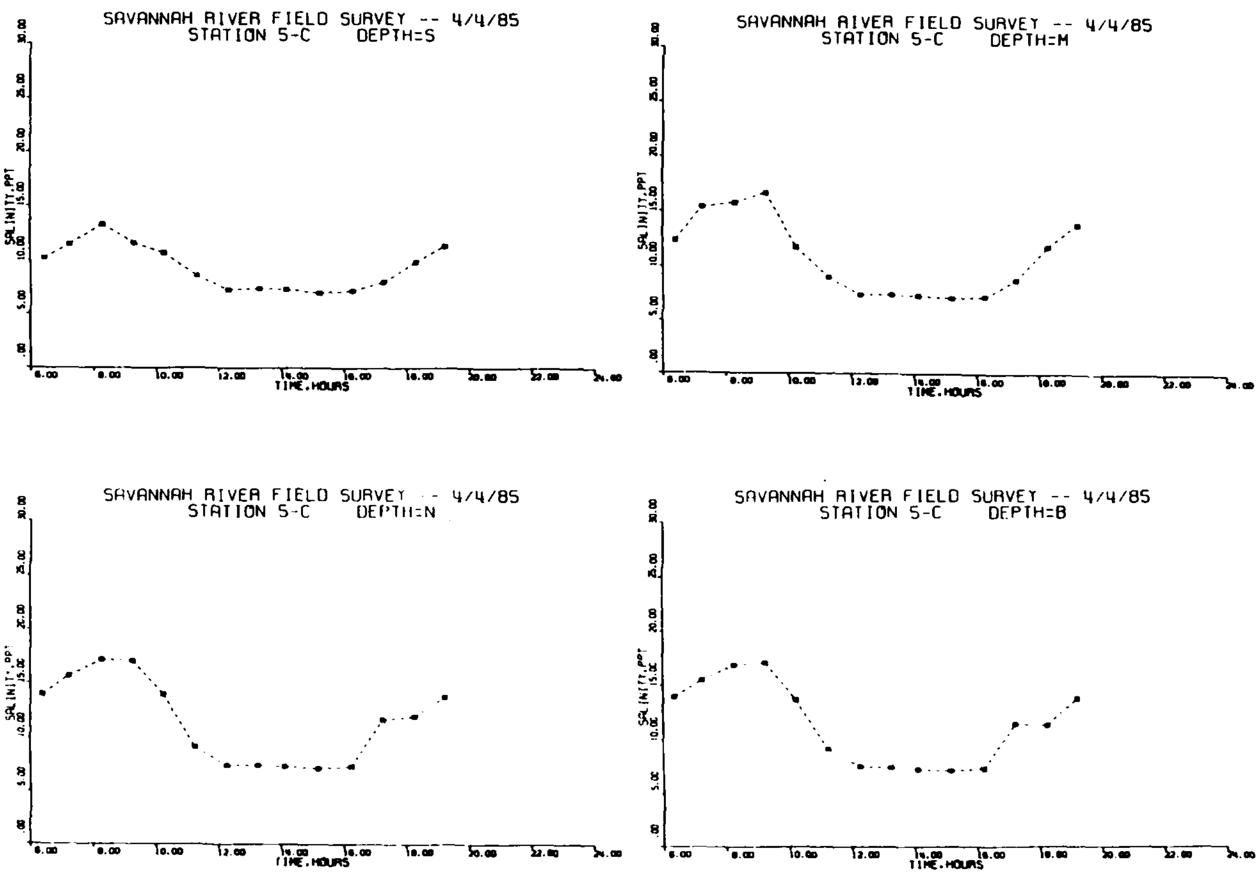


Figure C15. Salinity at Range 5 on right prism line

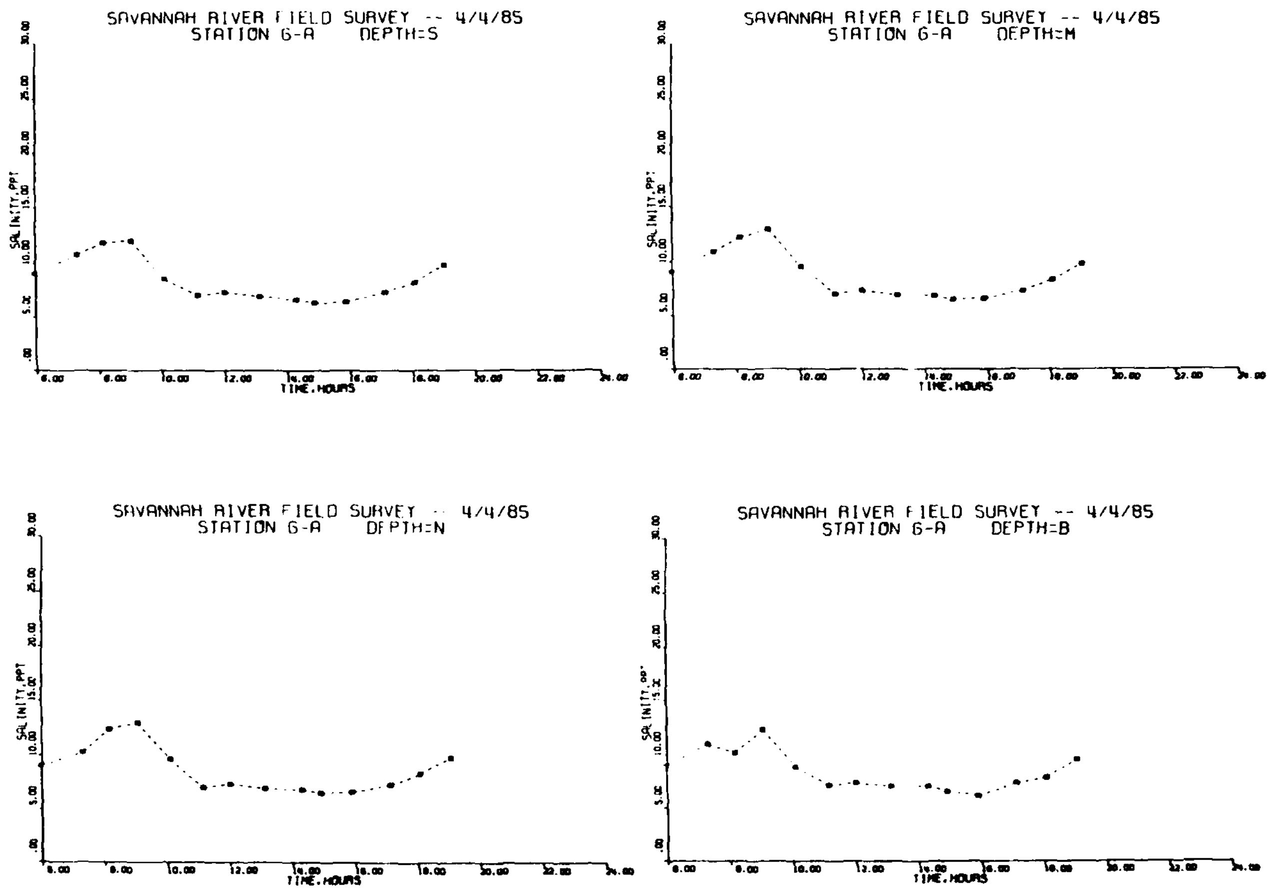


Figure C16. Salinity at Range 6 on left prism line

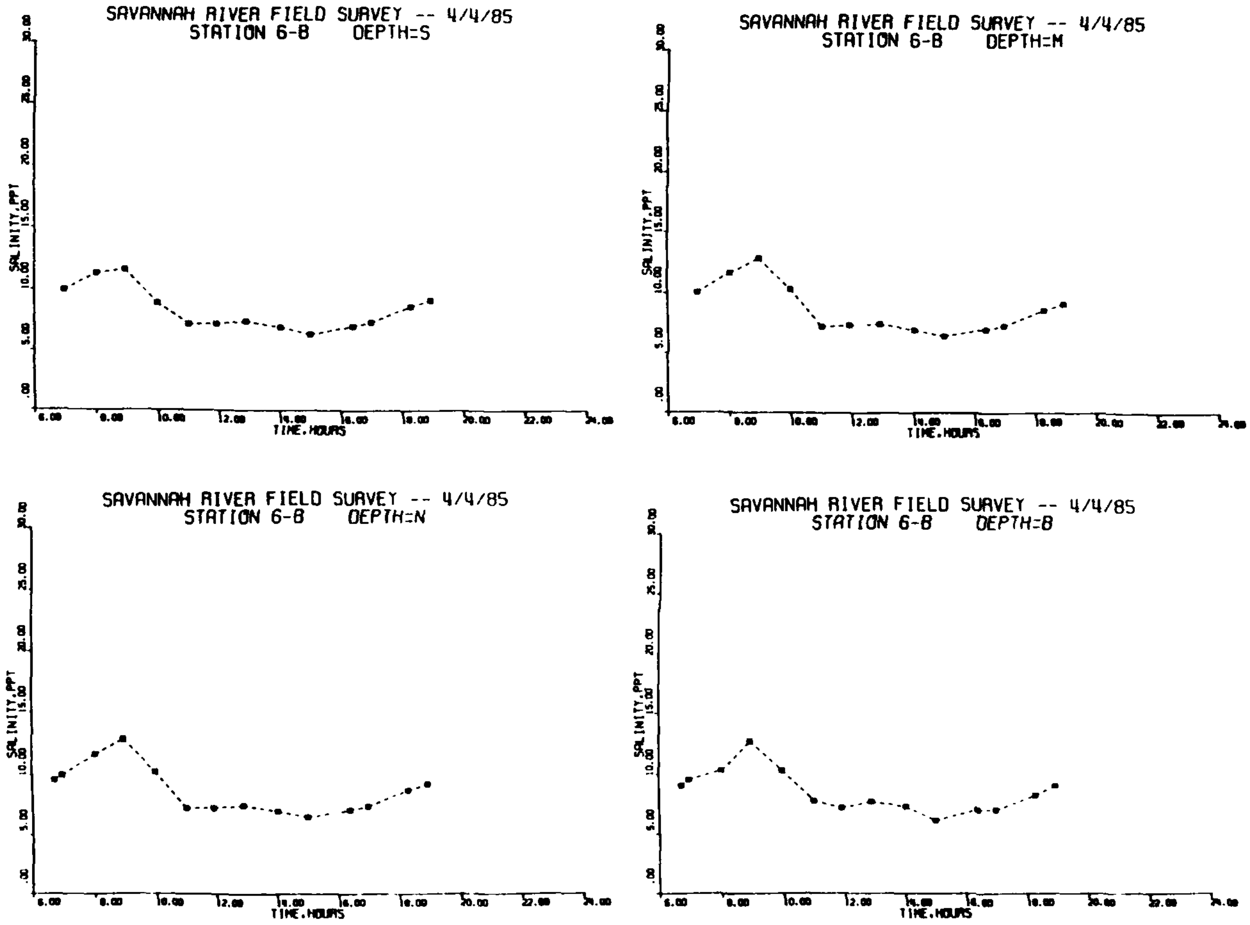


Figure C17. Salinity at Range 6 in center of channel

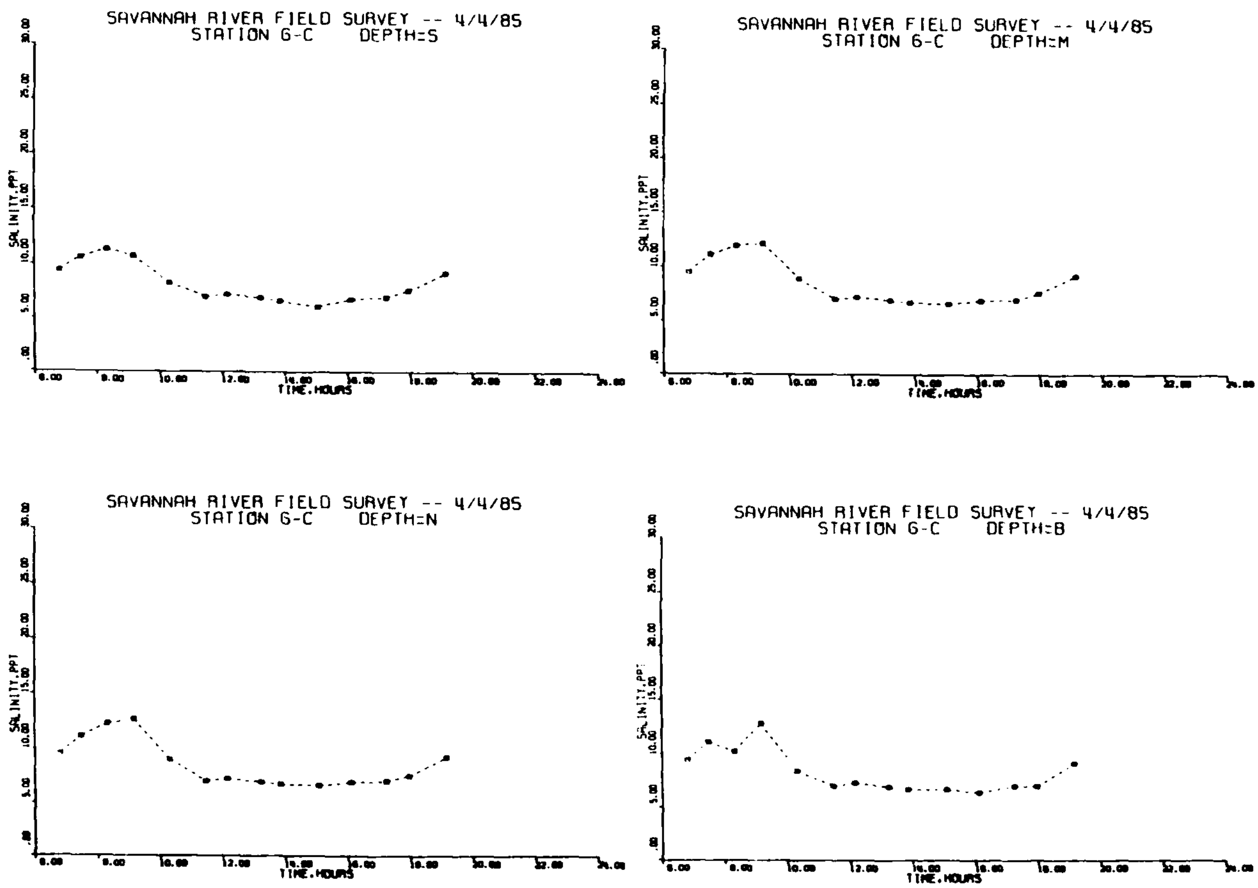


Figure C18. Salinity at Range 6 on right prism line

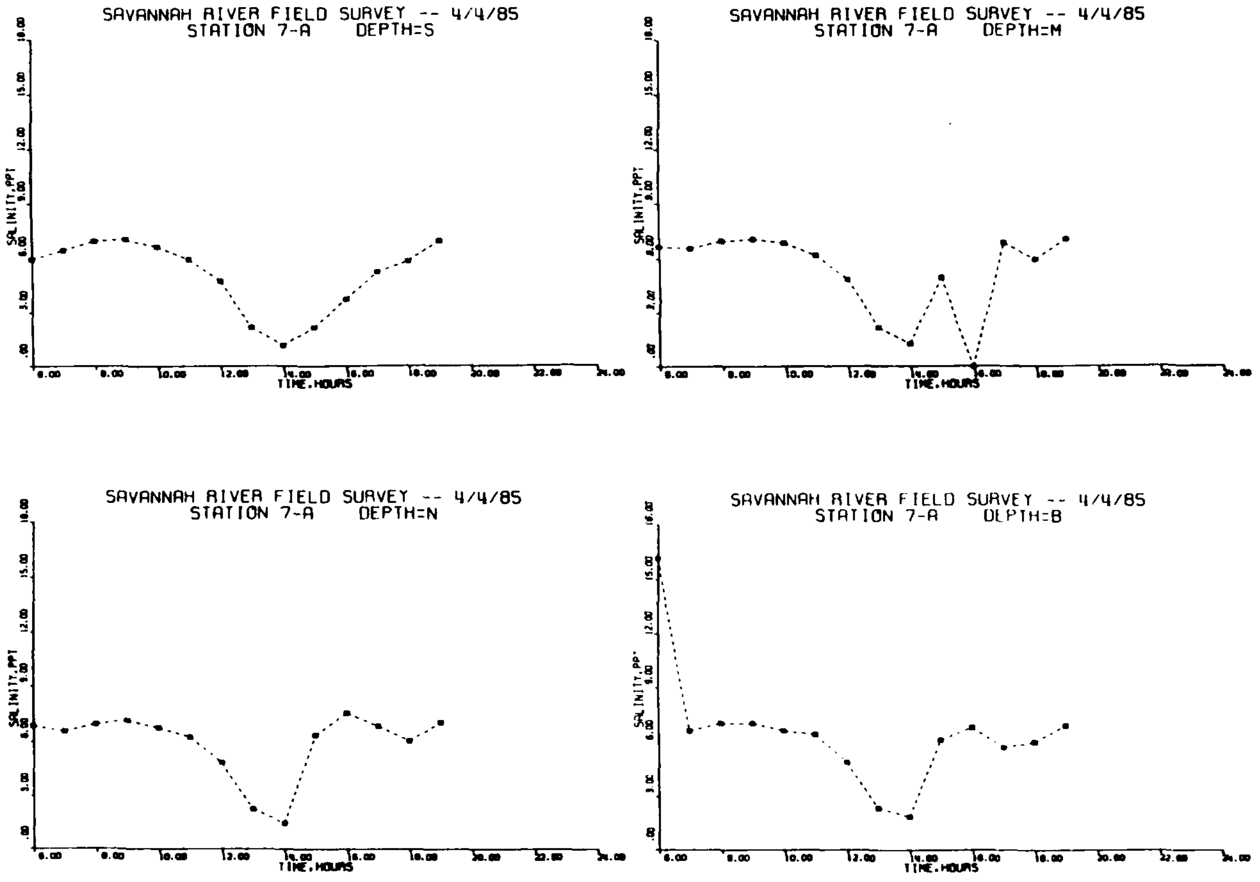


Figure C19. Salinity at Range 7 on left prism line

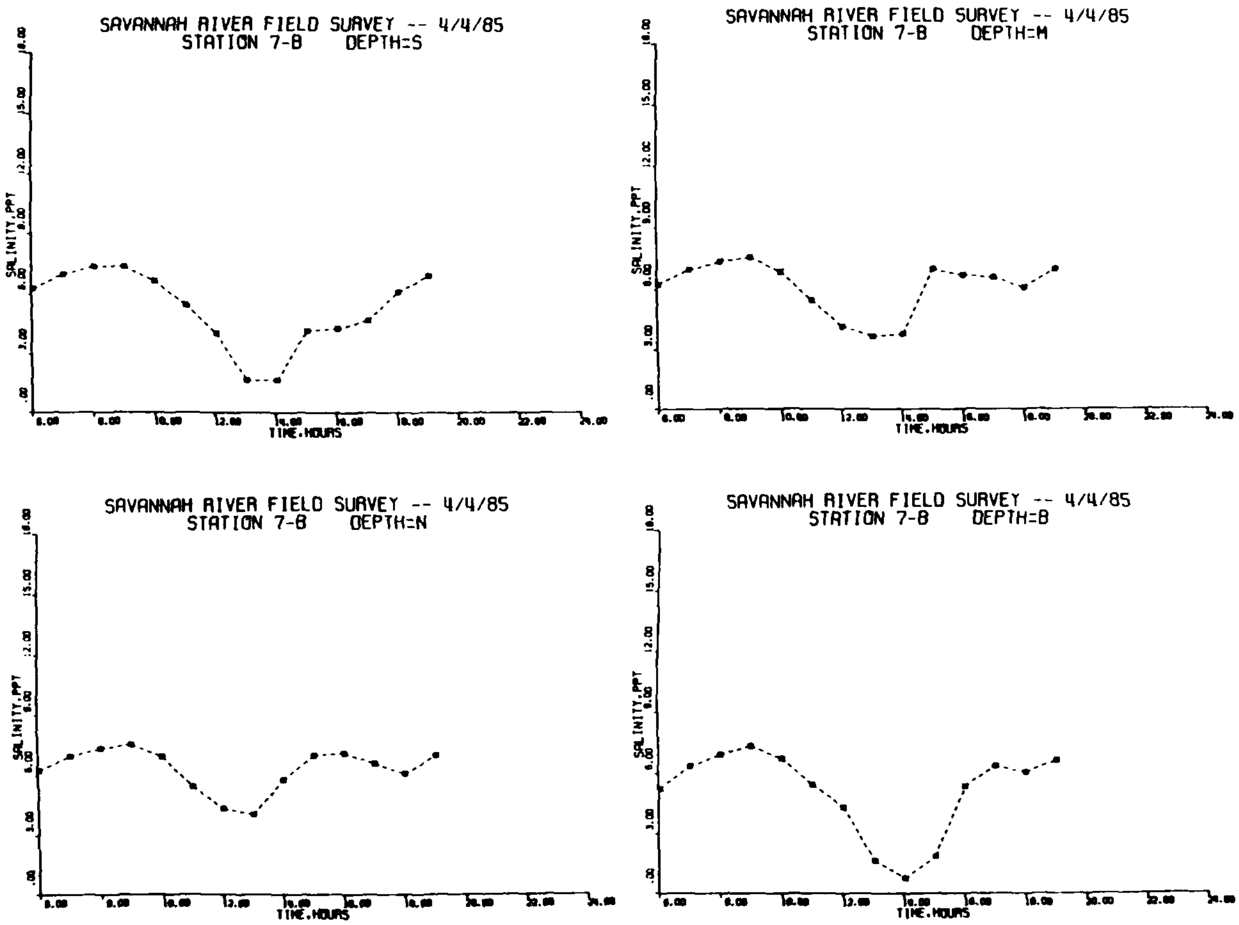


Figure C20. Salinity at Range 7 in center of channel

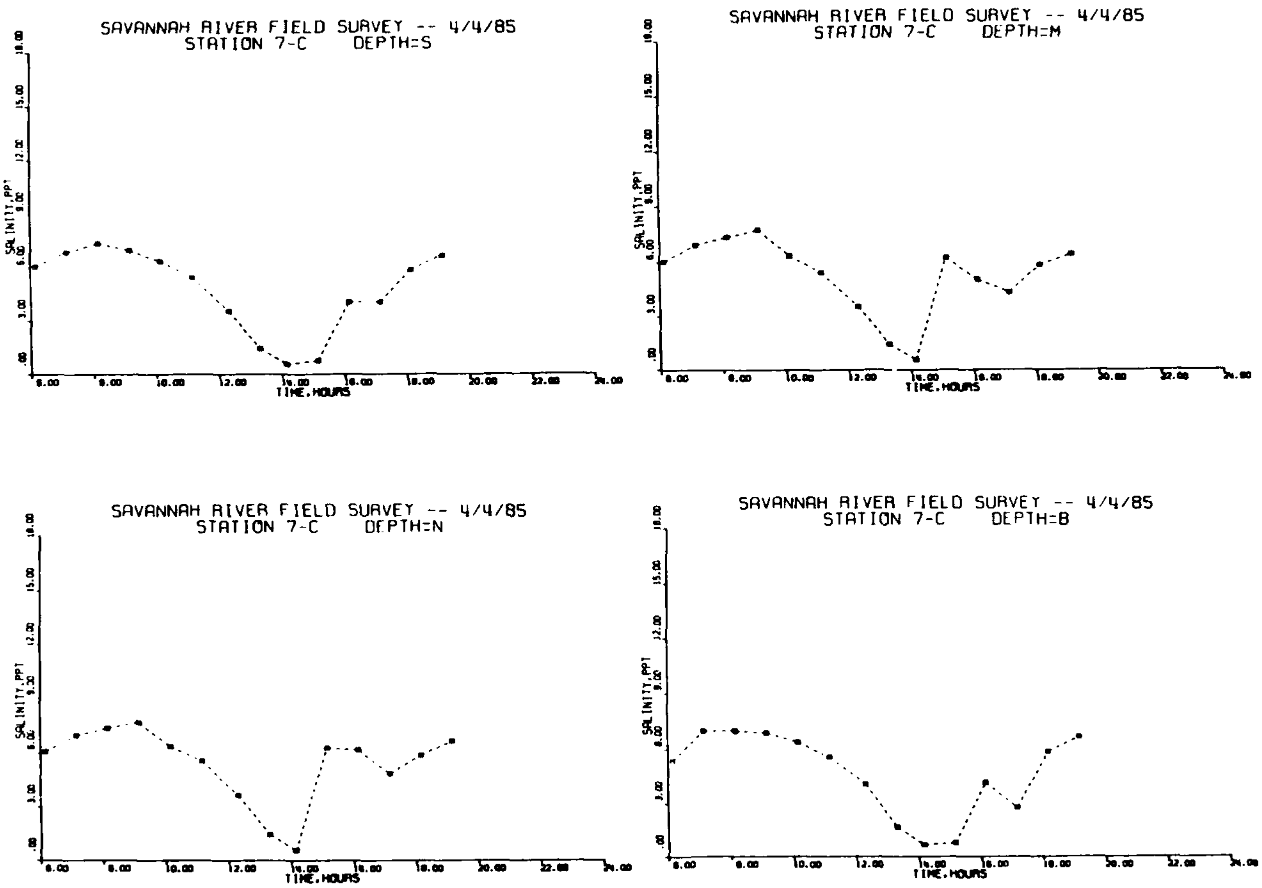


Figure C21. Salinity at Range 7 on right prism line

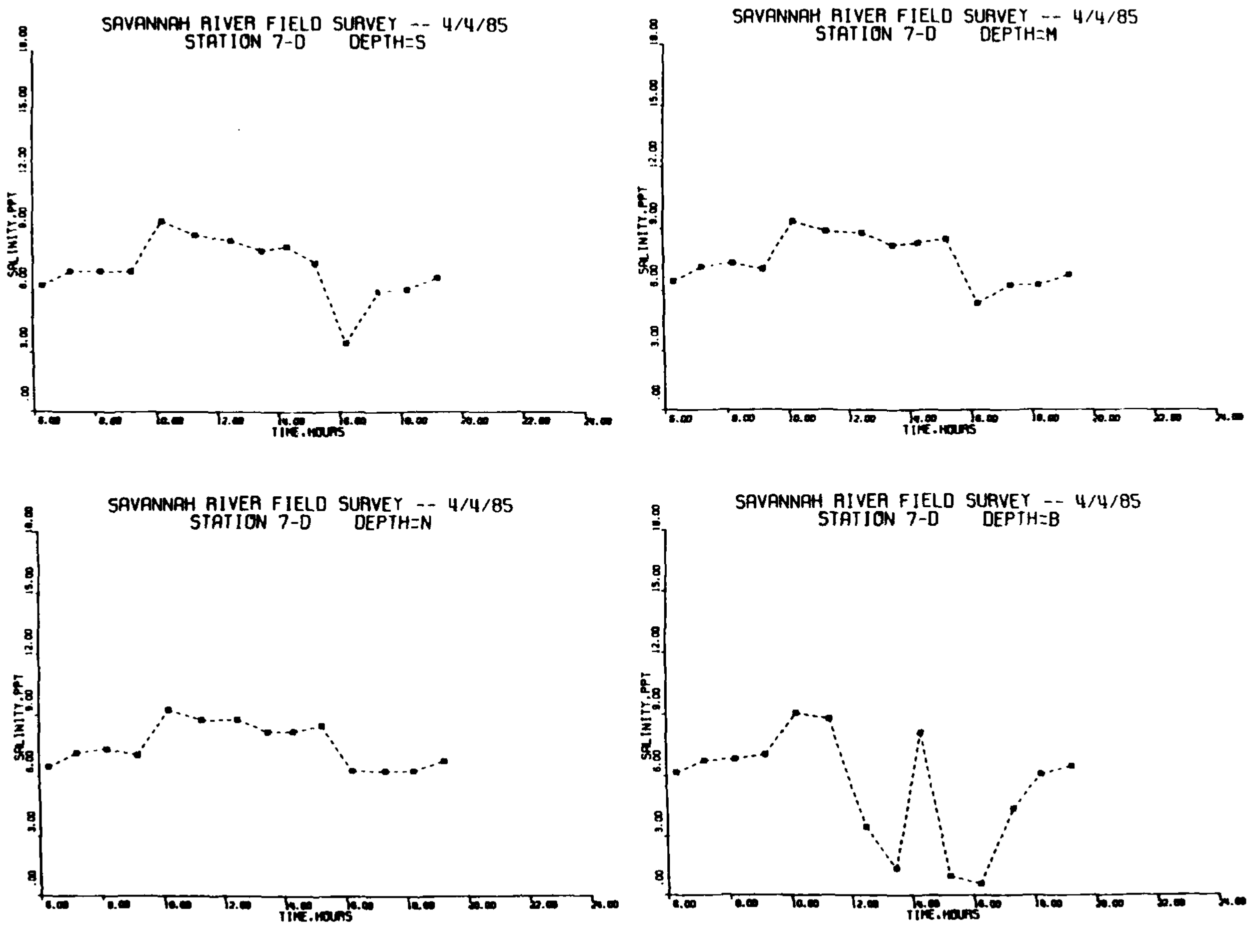


Figure C22. Salinity at Range 7 on Middle River on left prism line

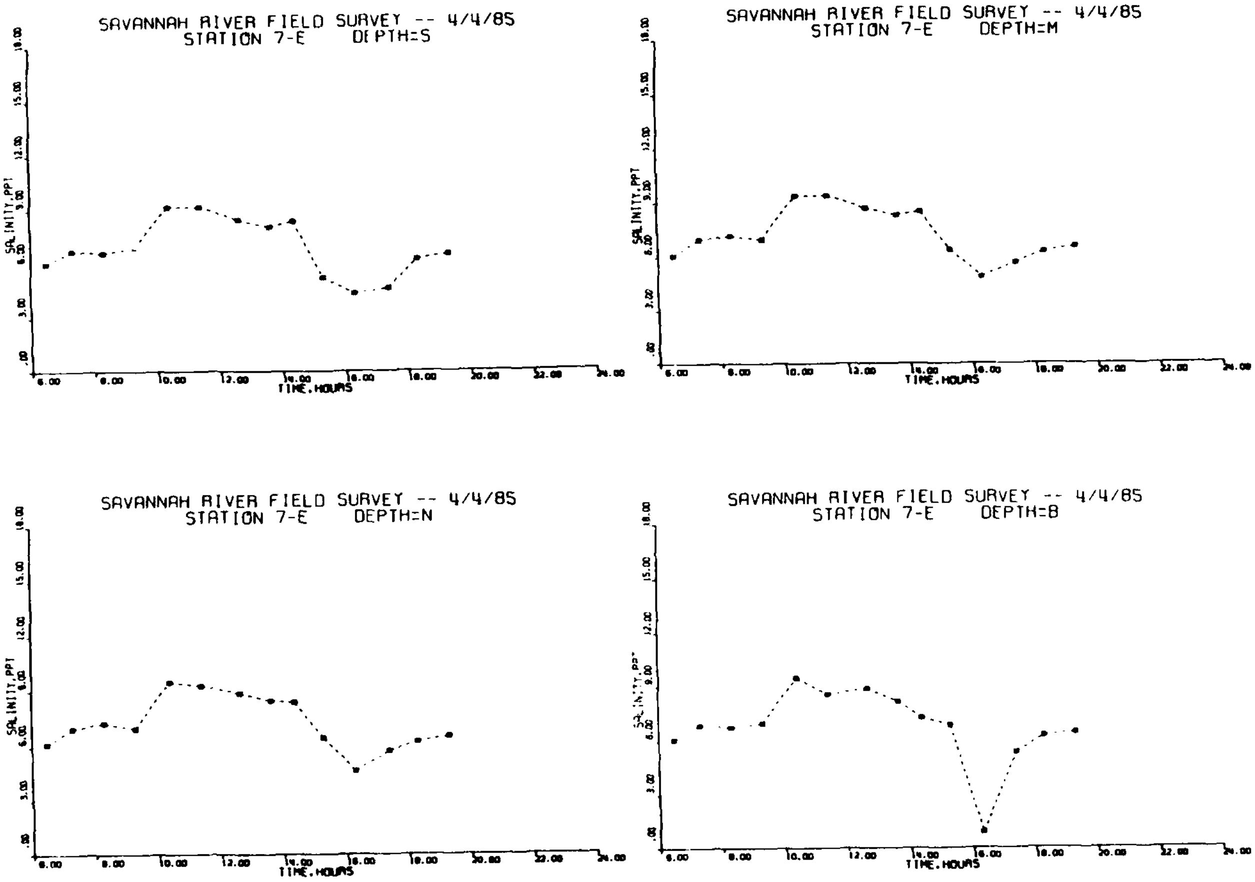


Figure C23. Salinity at Range 7 on Middle River on right prism line

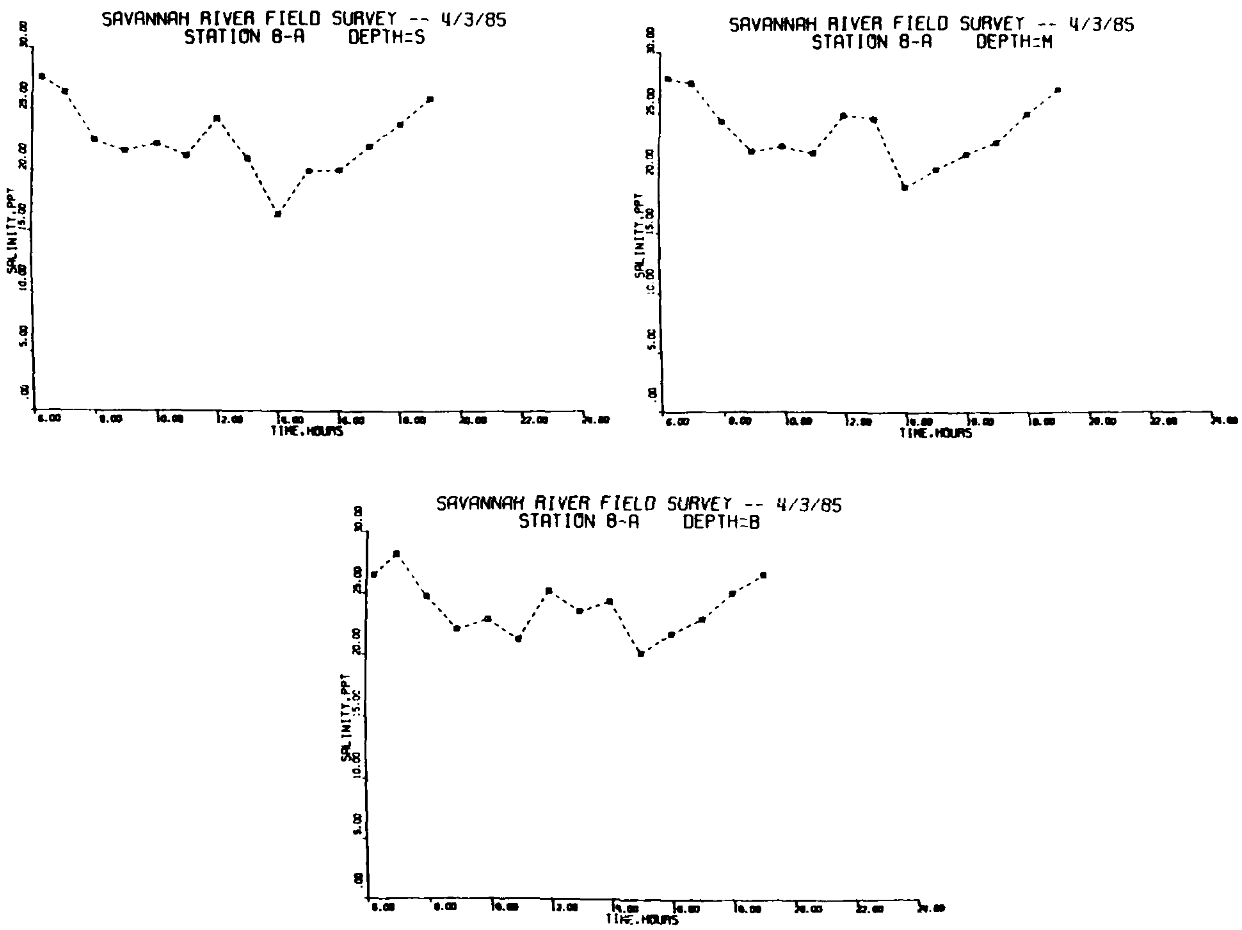


Figure C24. Salinity at Range 8 at center of channel

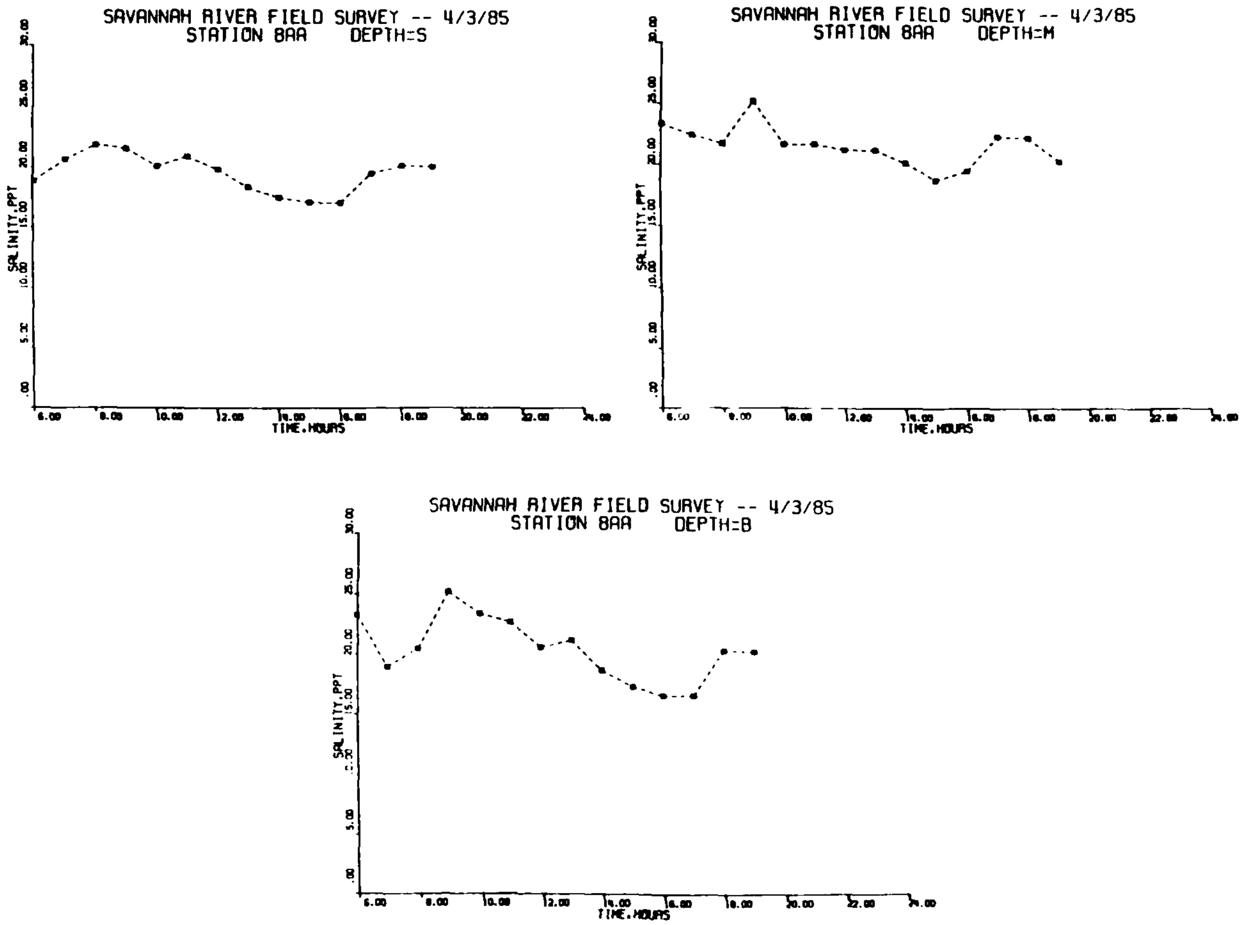


Figure C25. Salinity at Range 8A at center of channel

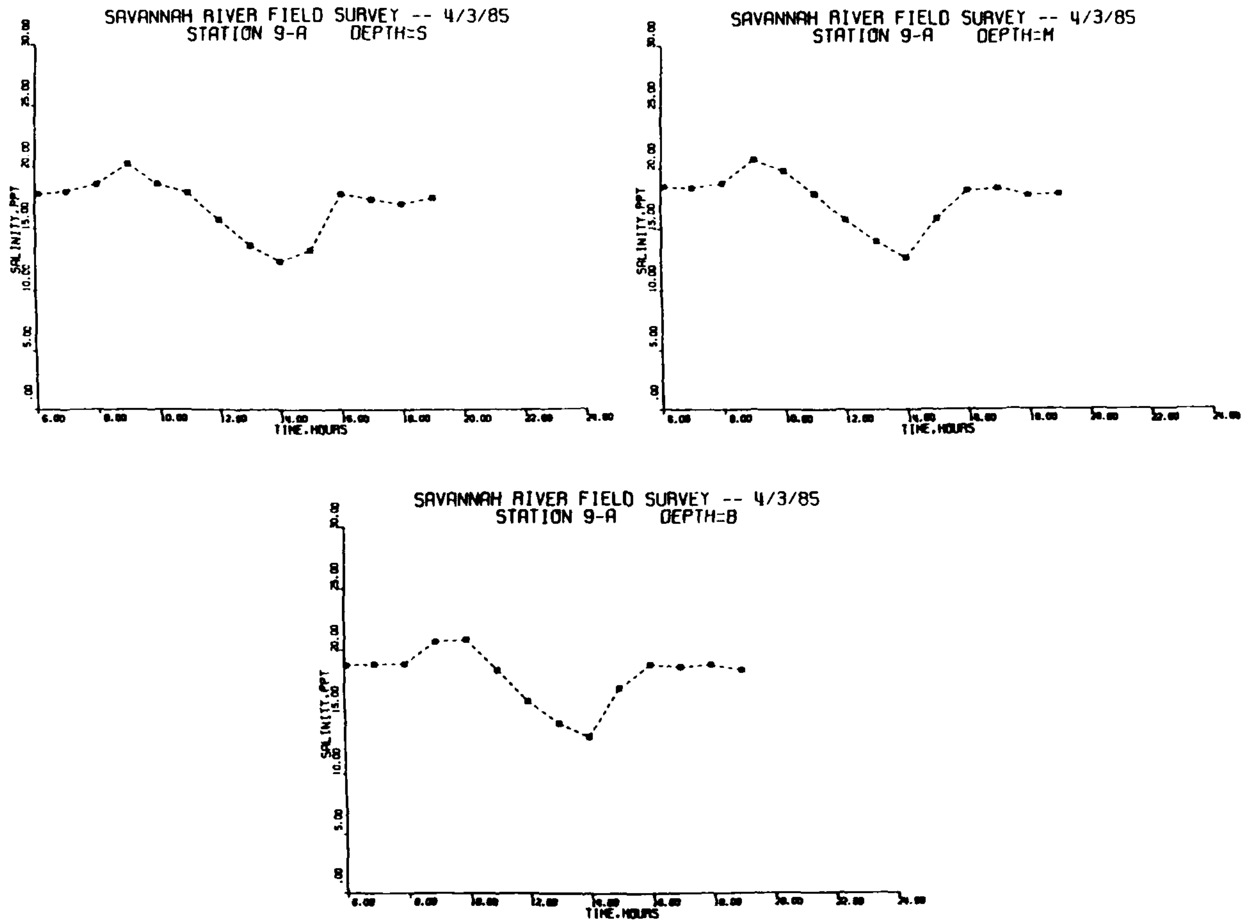


Figure C26. Salinity at Range 9 in center of channel

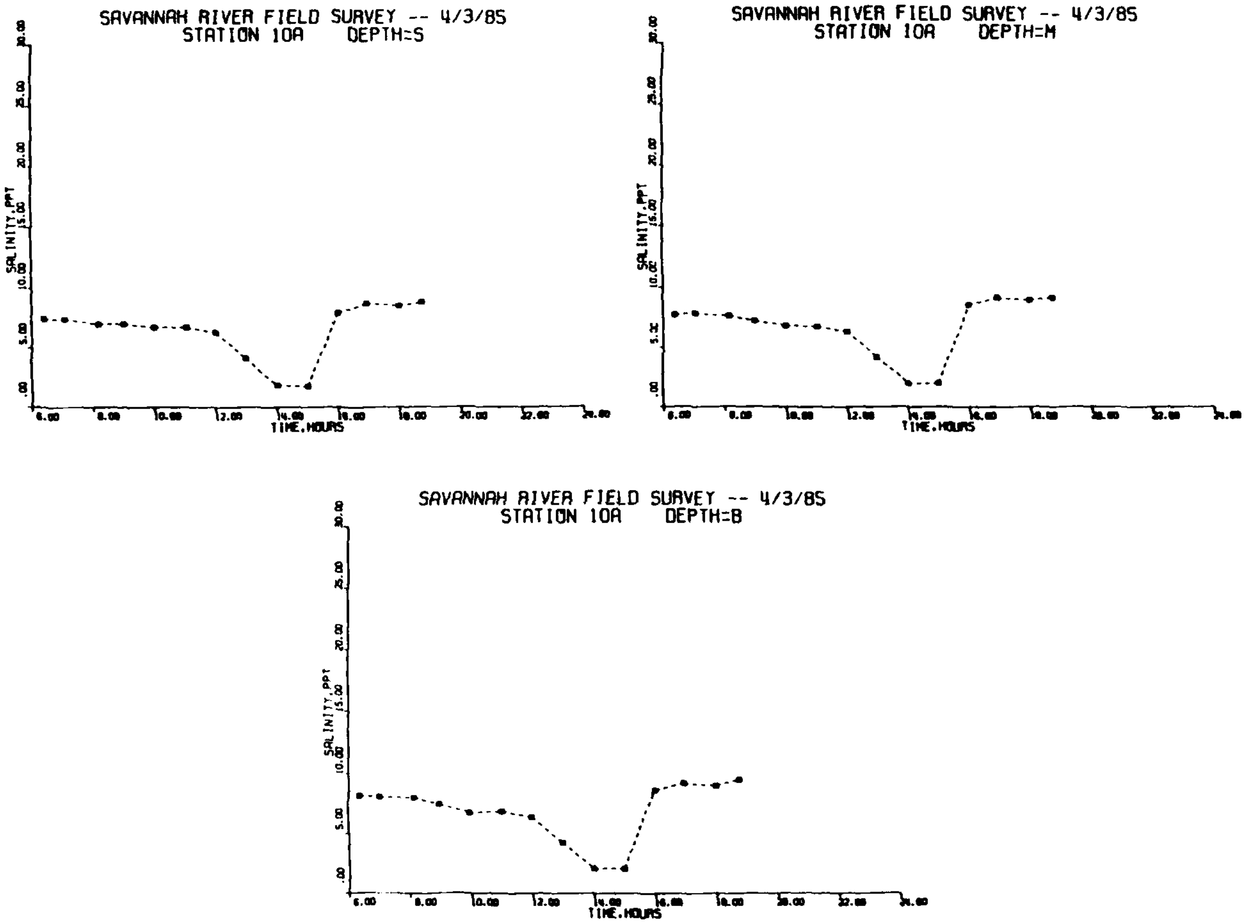


Figure C27. Salinity at Range 10 in center of channel

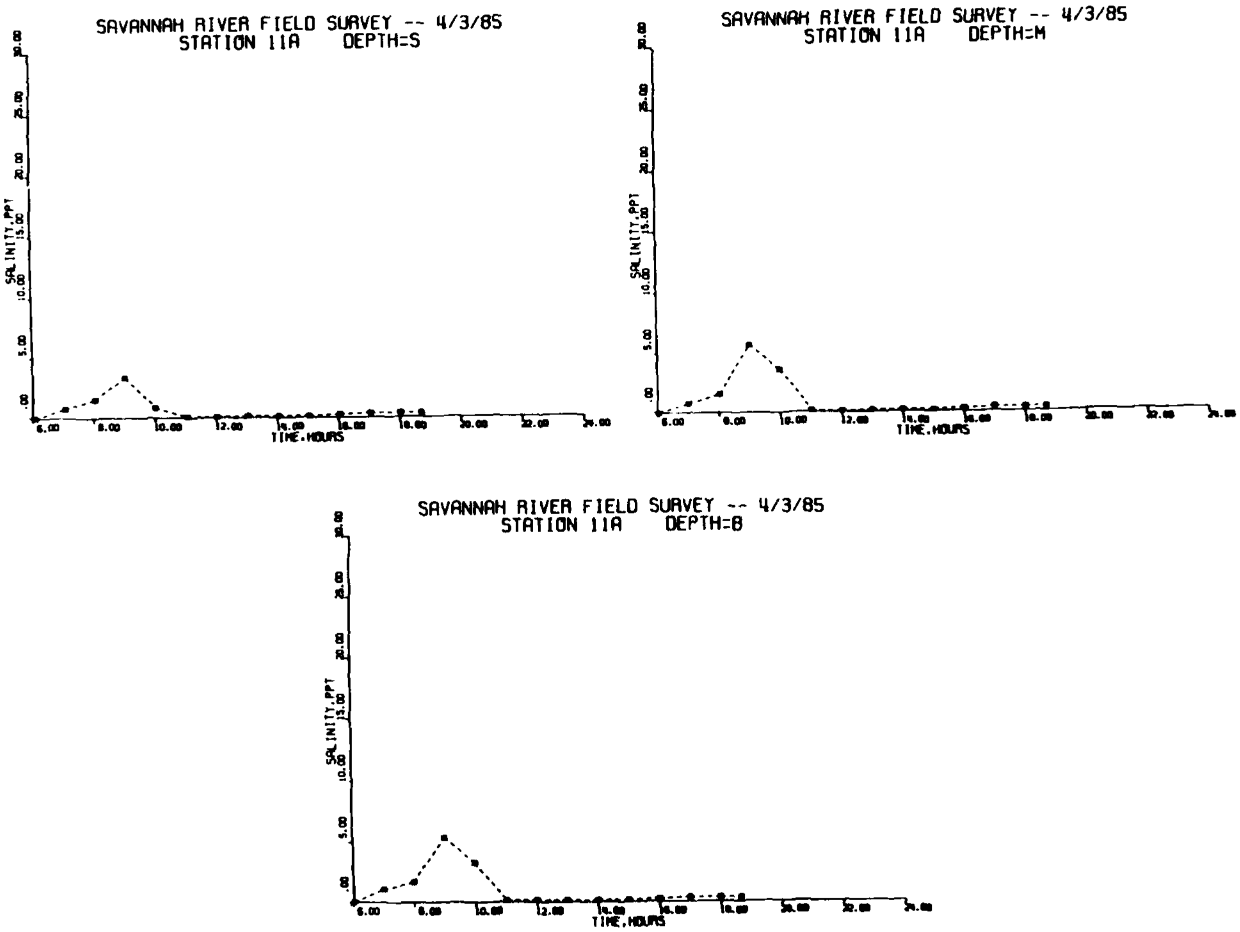


Figure C28. Salinity at Range 11 in center of channel

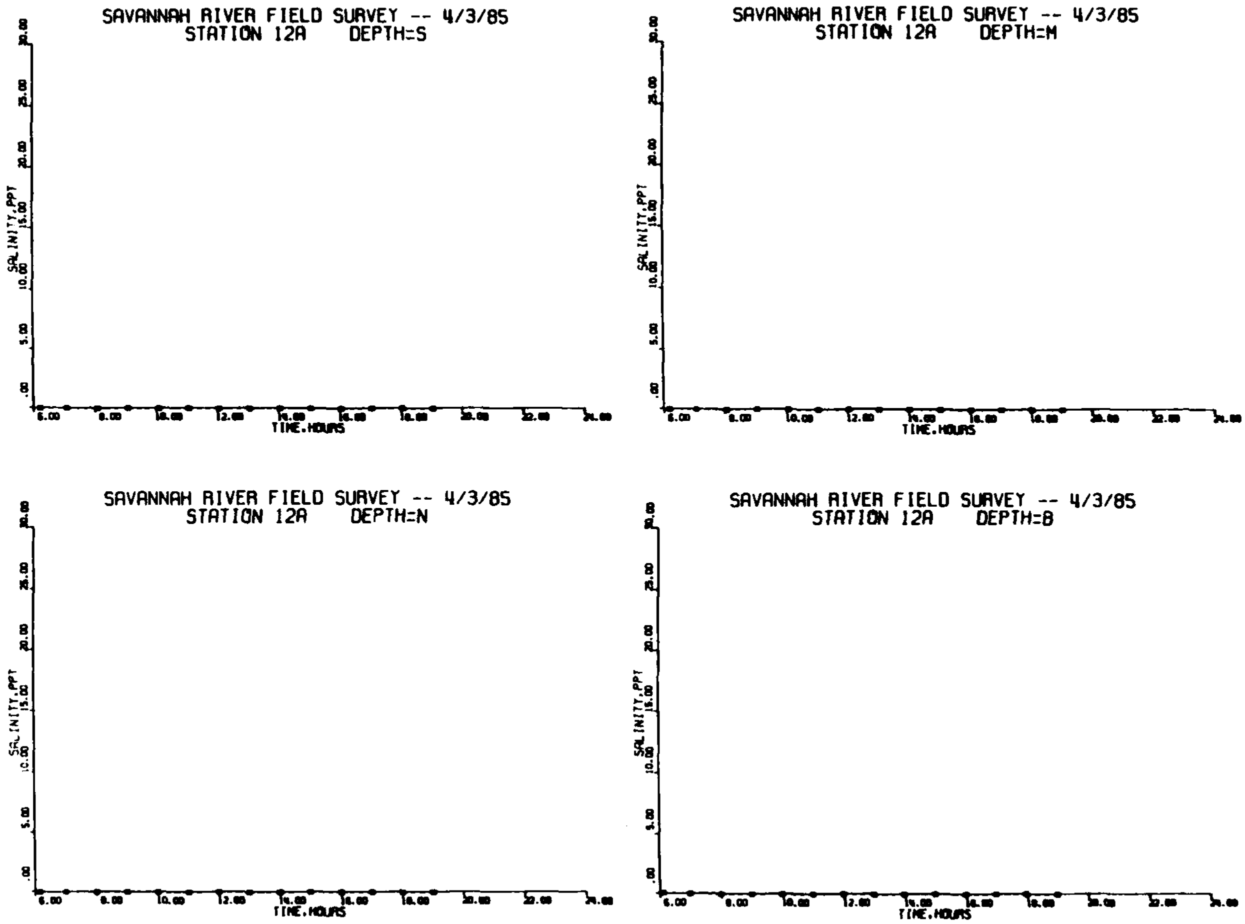


Figure C29. Salinity at Range 12 in center of channel

APPENDIX D: SUSPENDED SEDIMENT DATA

Suspended sediment data were collected at Ranges 8-12 on 3 April 1985 from 0600 to 1900 and at Ranges 1-7 on 4 April 1985 from 0600 to 1900. Measurements were taken at 1-hr intervals along the left (A) and right (C) channel prism line and in the center (B) of the channel at Ranges 1-6 and Range 7 in Front River. At Ranges 8-12, measurements were taken only in the center of the channel. Suspended sediment plots are presented at each range (labeled stations on the plot) in Figures D1-D29. The following notation is used to indicate the vertical location of the measurement:

S = Surface

1 = Two-thirds above the bottom

M = Middepth

2 = One-third above the bottom

N = 4 ft above bottom

B = 2 ft above bottom

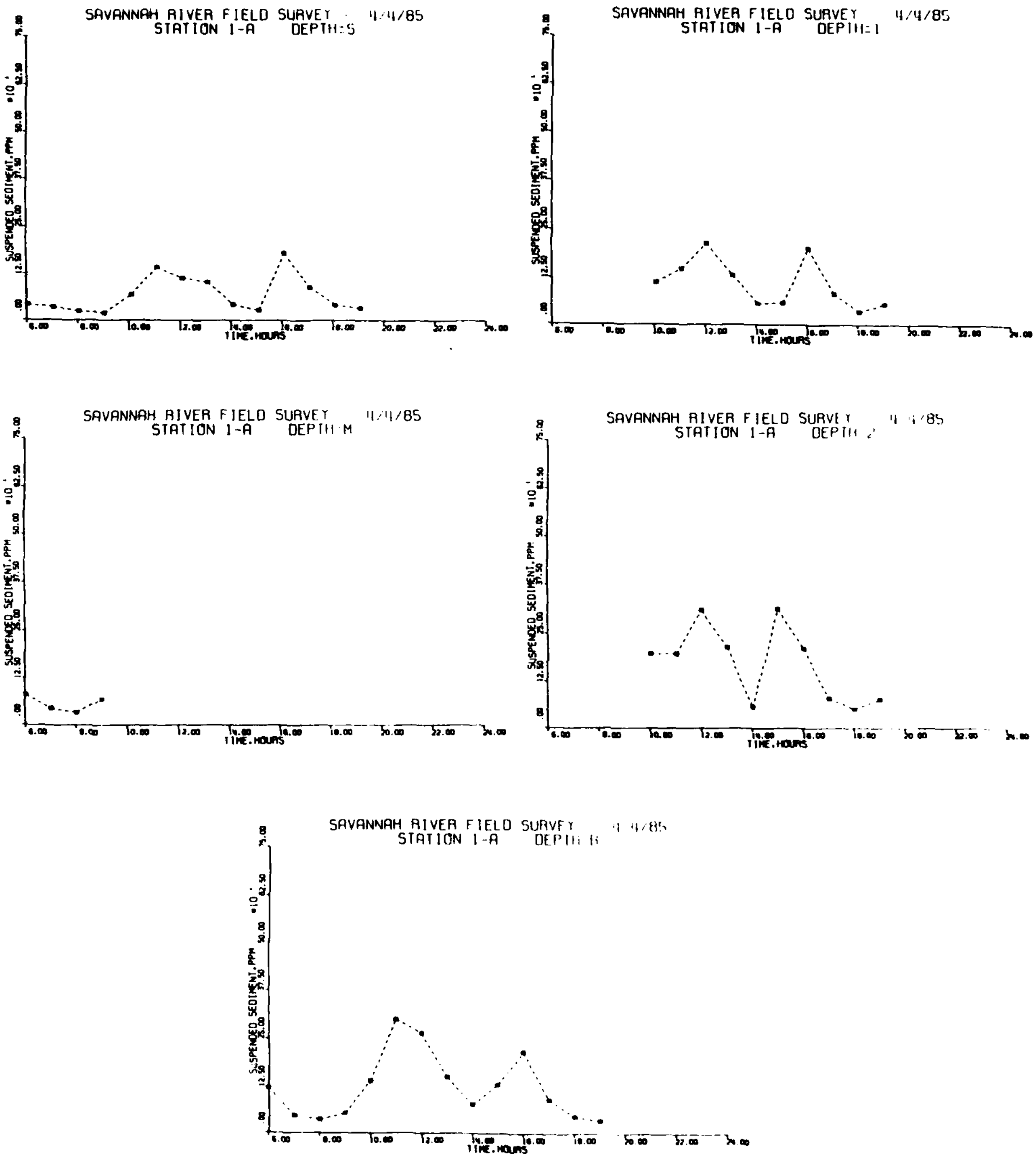


Figure D1. Suspended sediment at Range 1 on left prism line

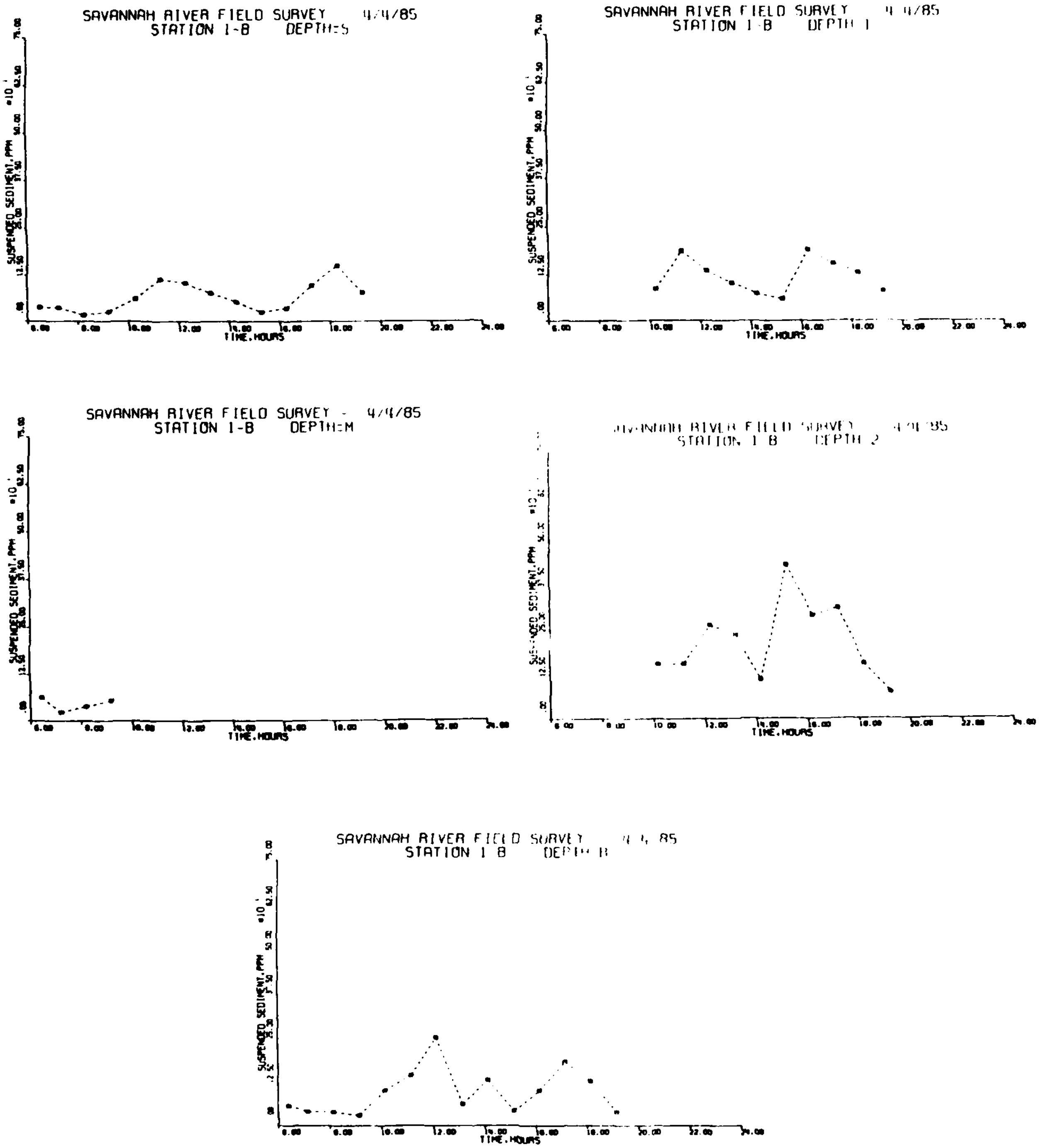


Figure D2. Suspended sediment at Range 1 in center of channel

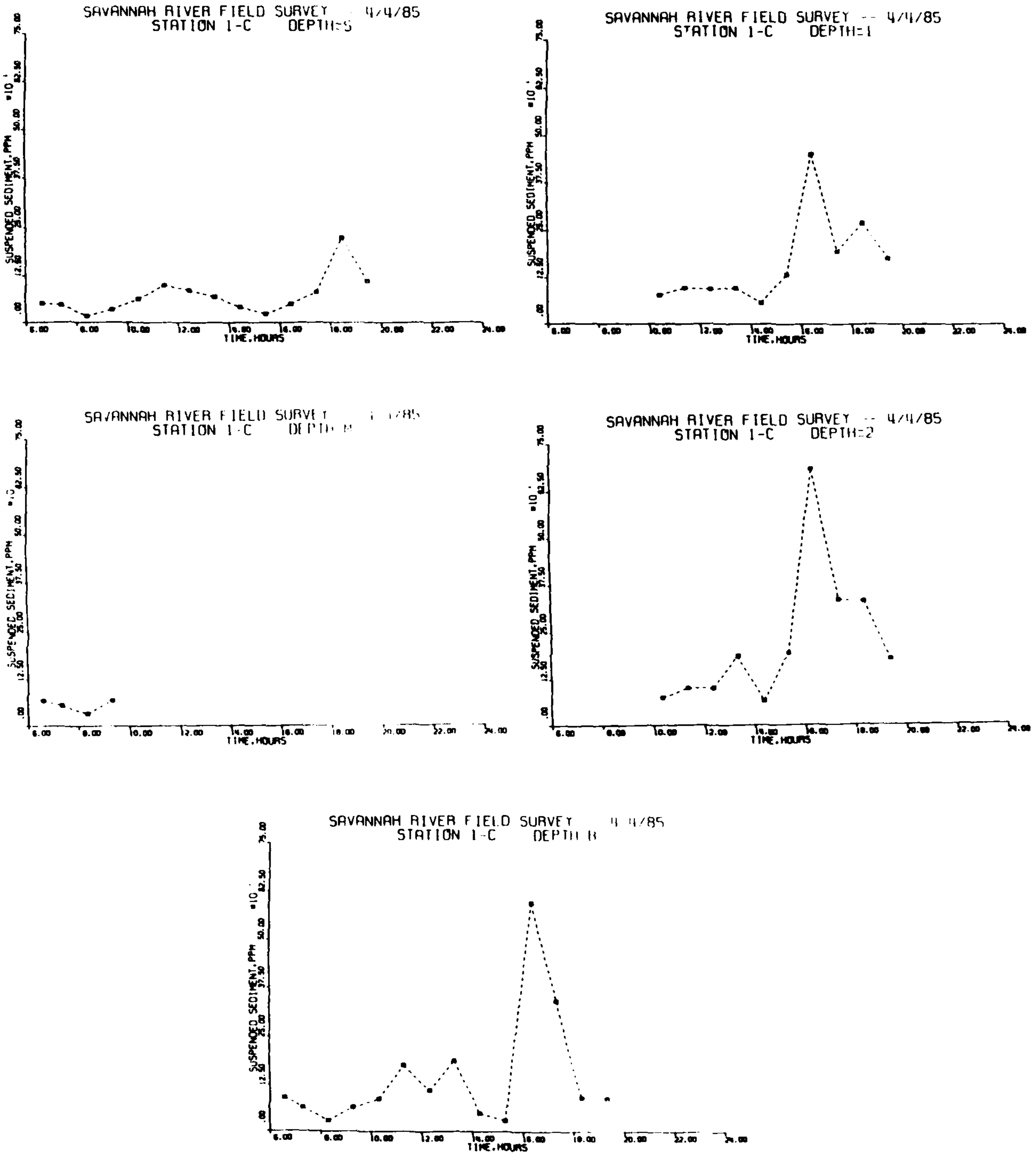


Figure D3. Suspended sediment at Range 1 on right prism line

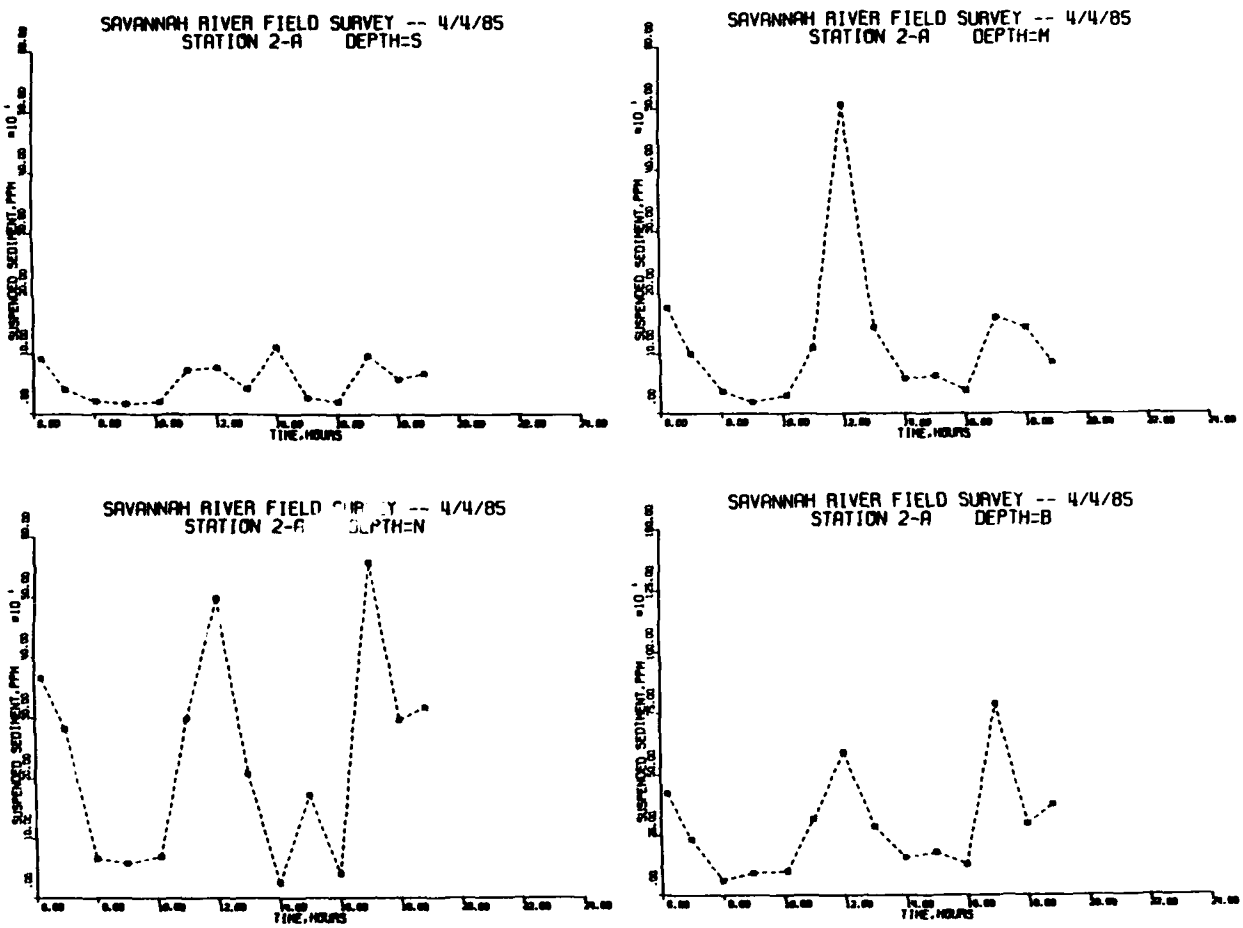


Figure D4. Suspended sediment at Range 2 on left prism line

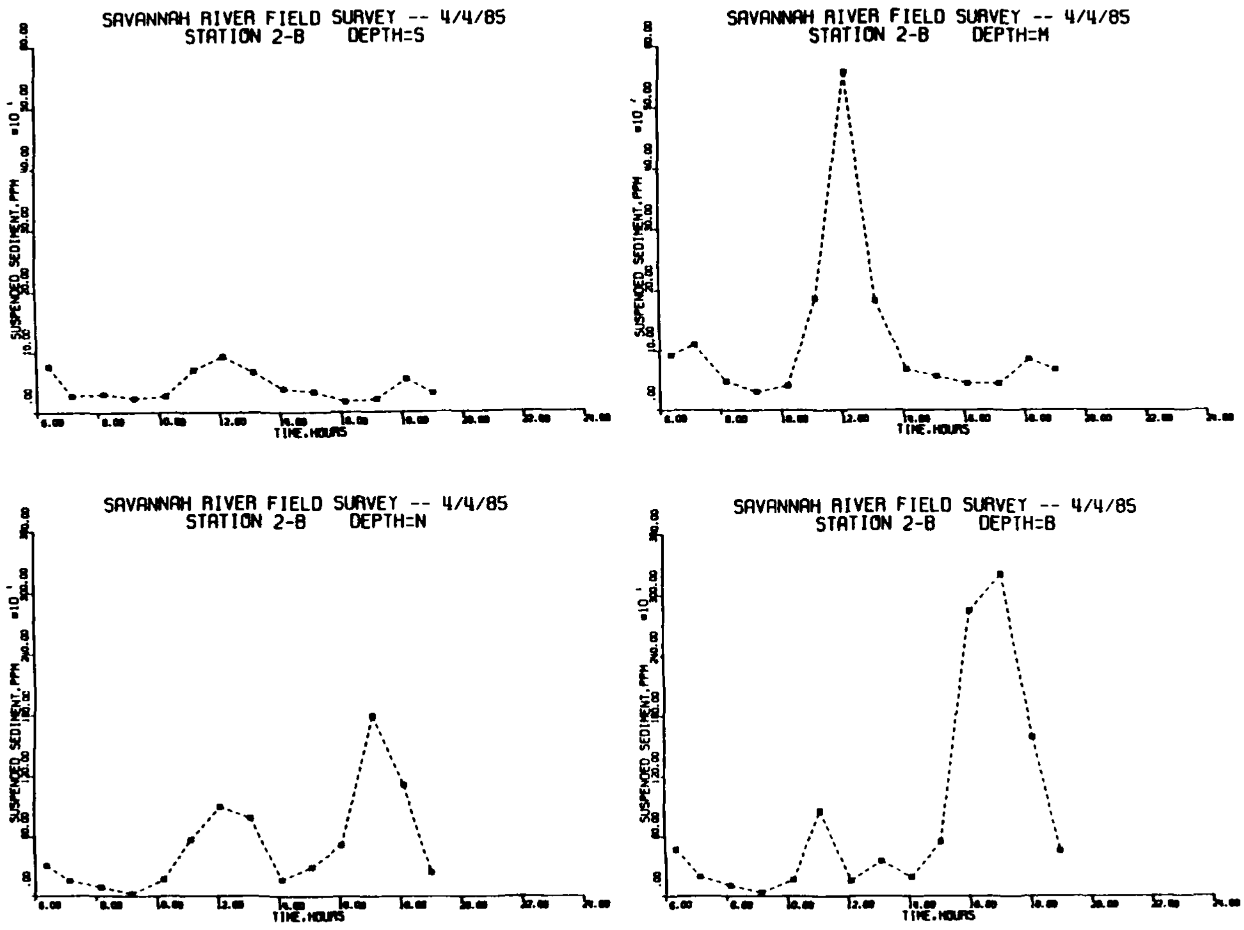


Figure D5. Suspended sediment at Range 2 in center of channel

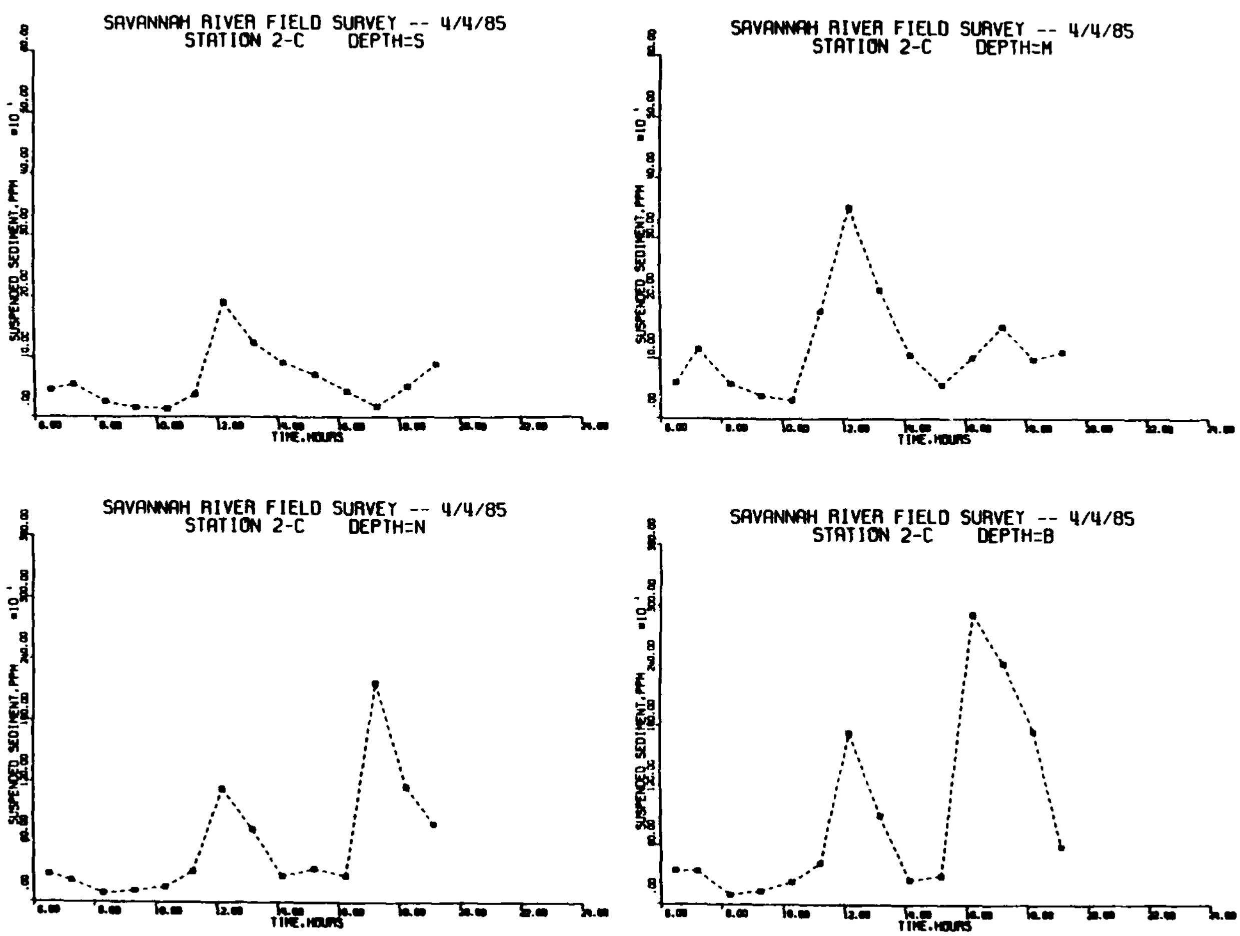


Figure D6. Suspended sediment at Range 2 on right prism line

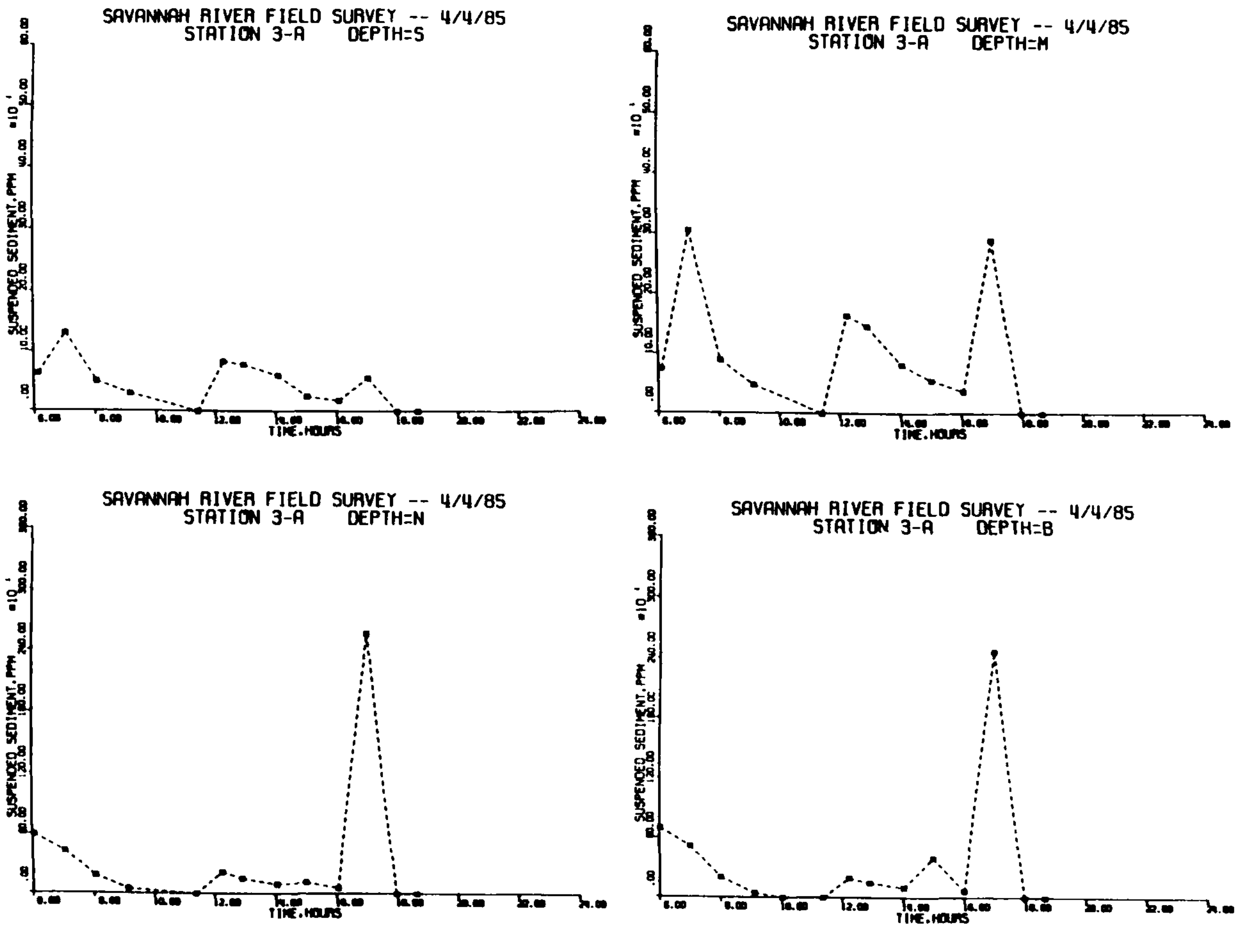


Figure D7. Suspended sediment at Range 3 on left prism line

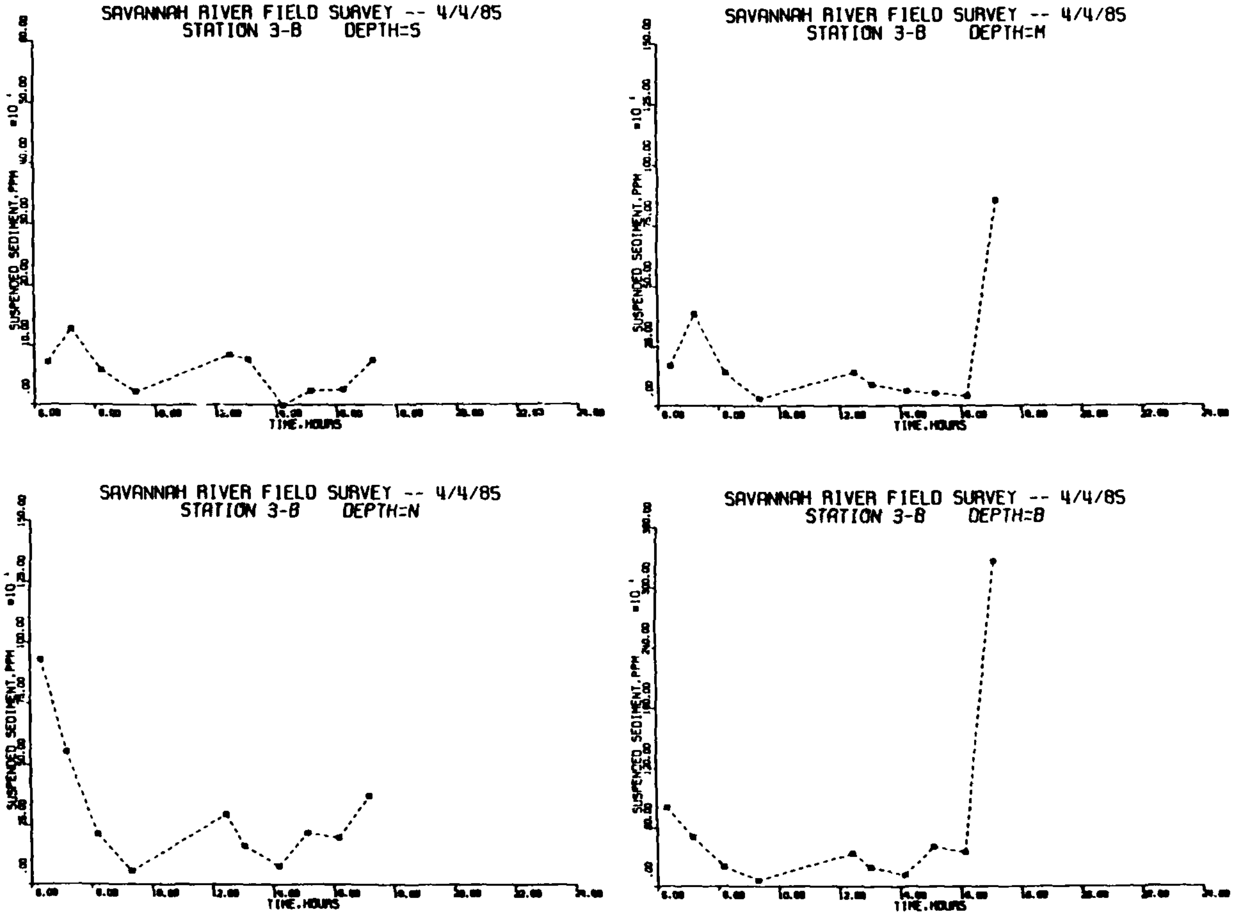


Figure D8. Suspended sediment at Range 3 in center of channel

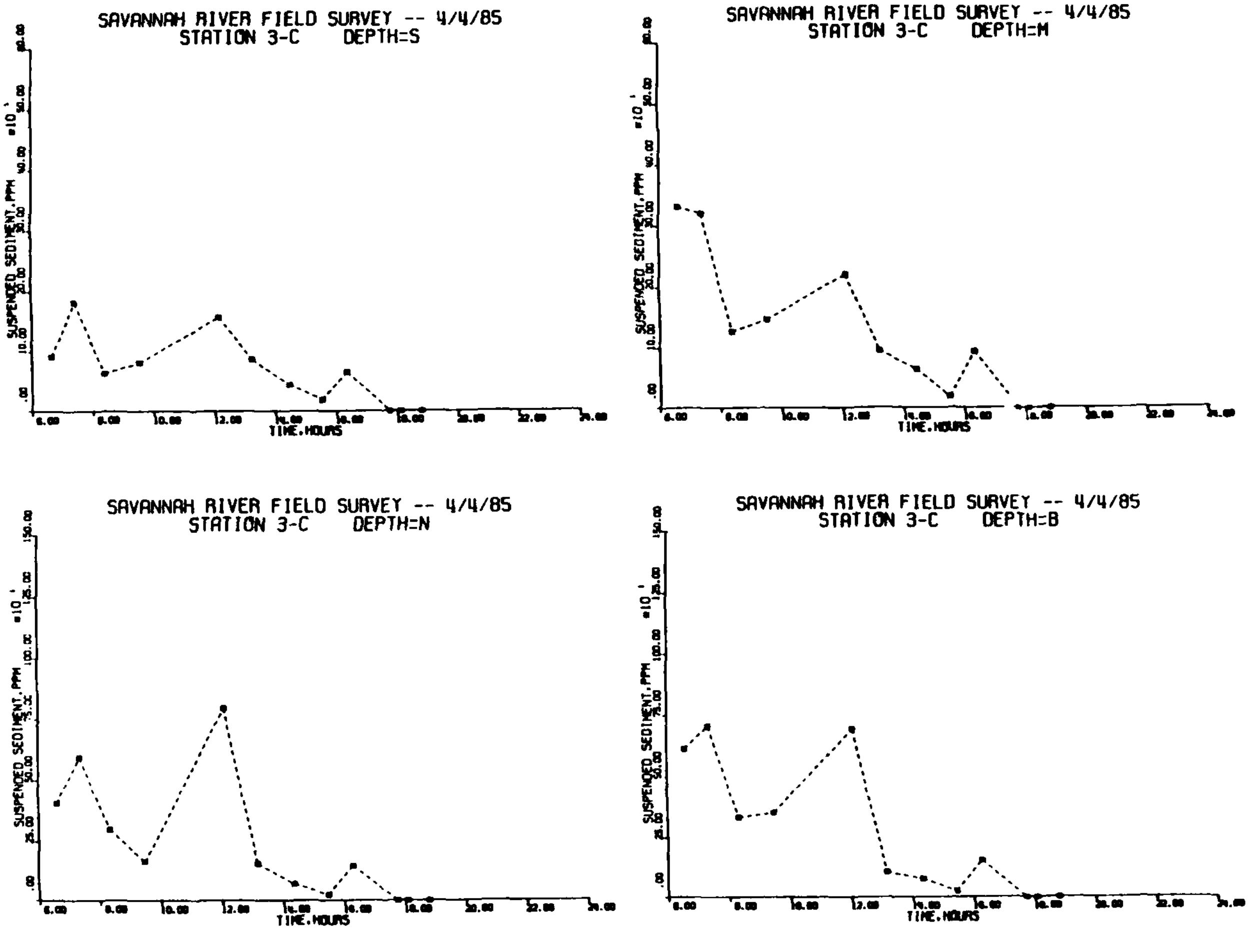


Figure D9. Suspended sediment at Range 3 on right prism line

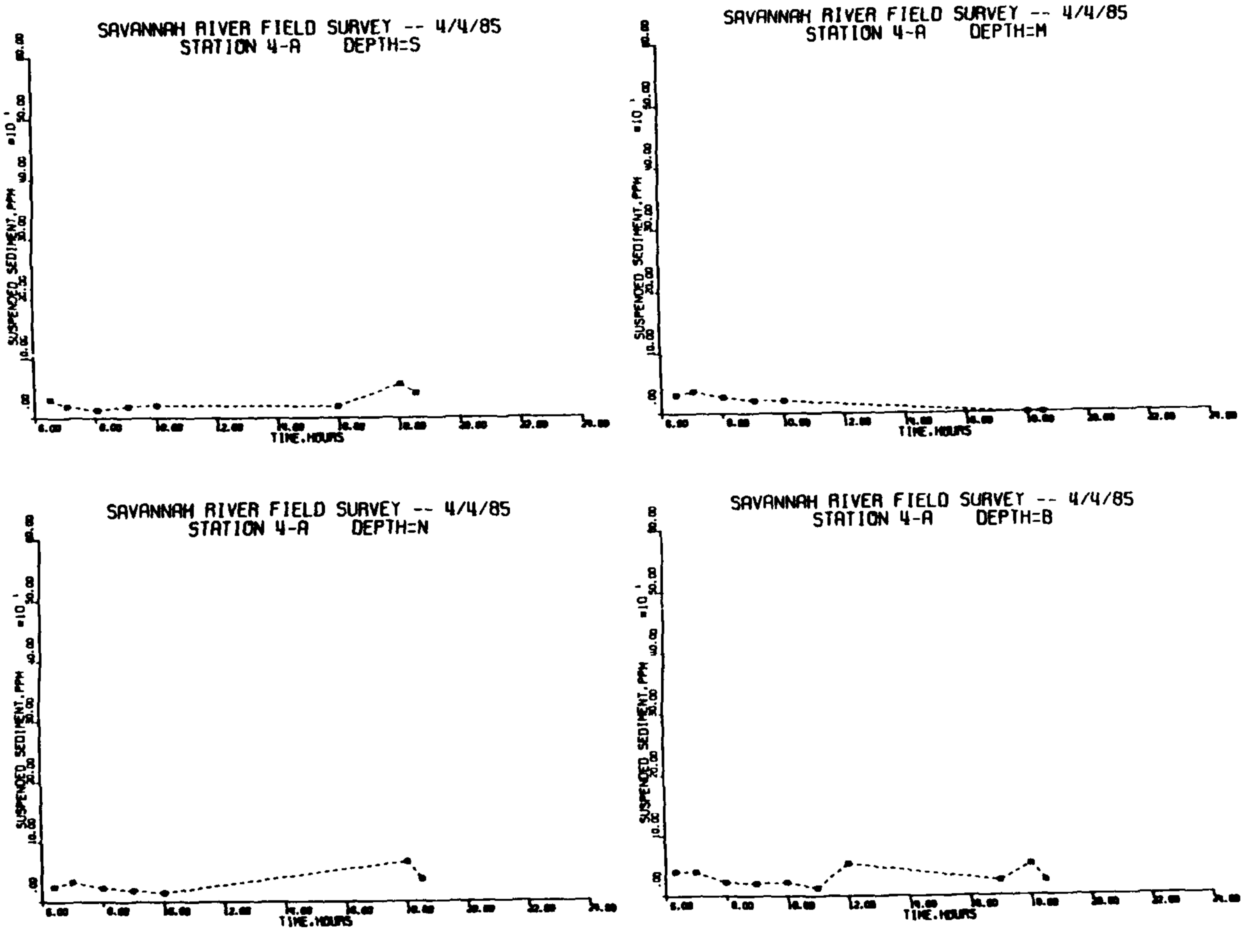


Figure D10. Suspended sediment at Range 4 on left prism line

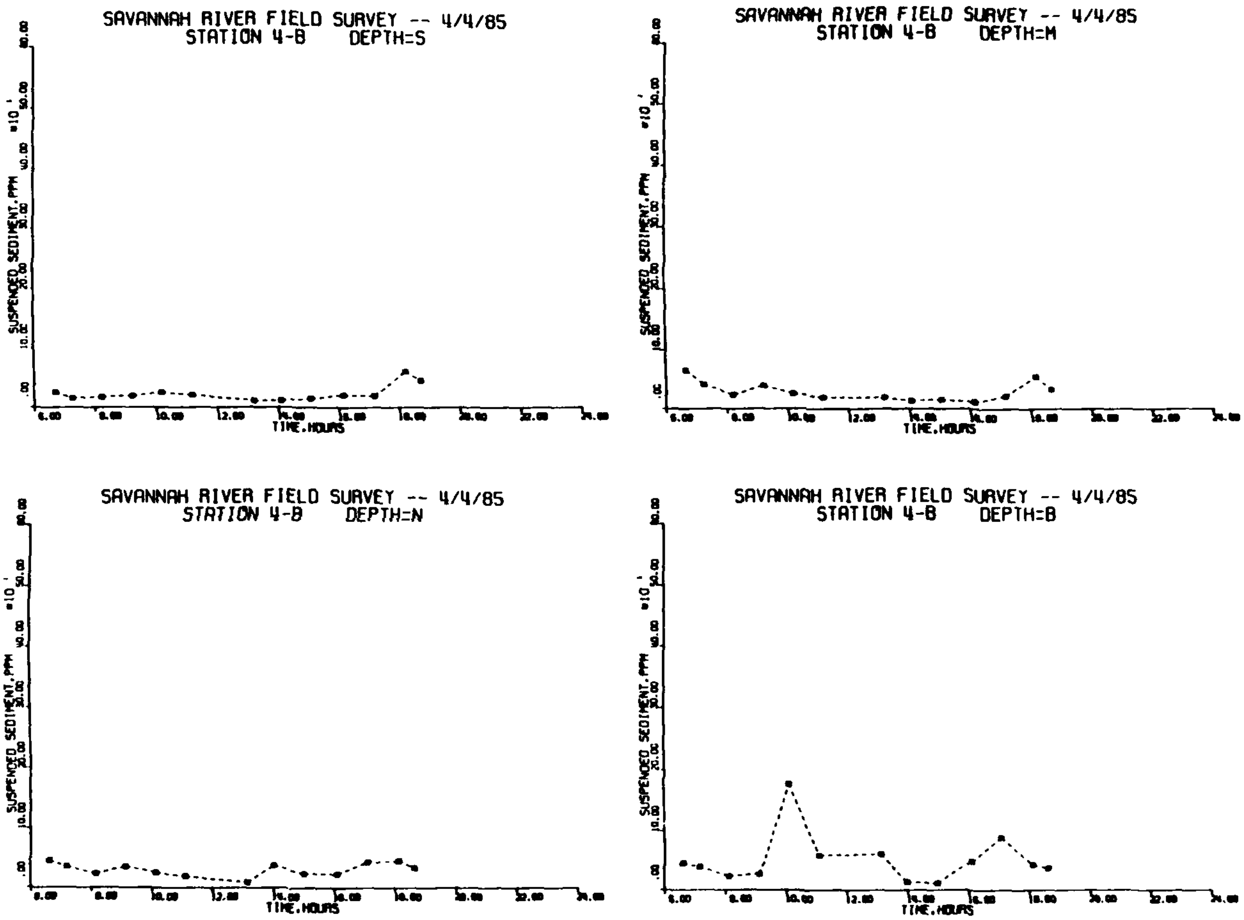


Figure D11. Suspended sediment at Range 4 in center of channel

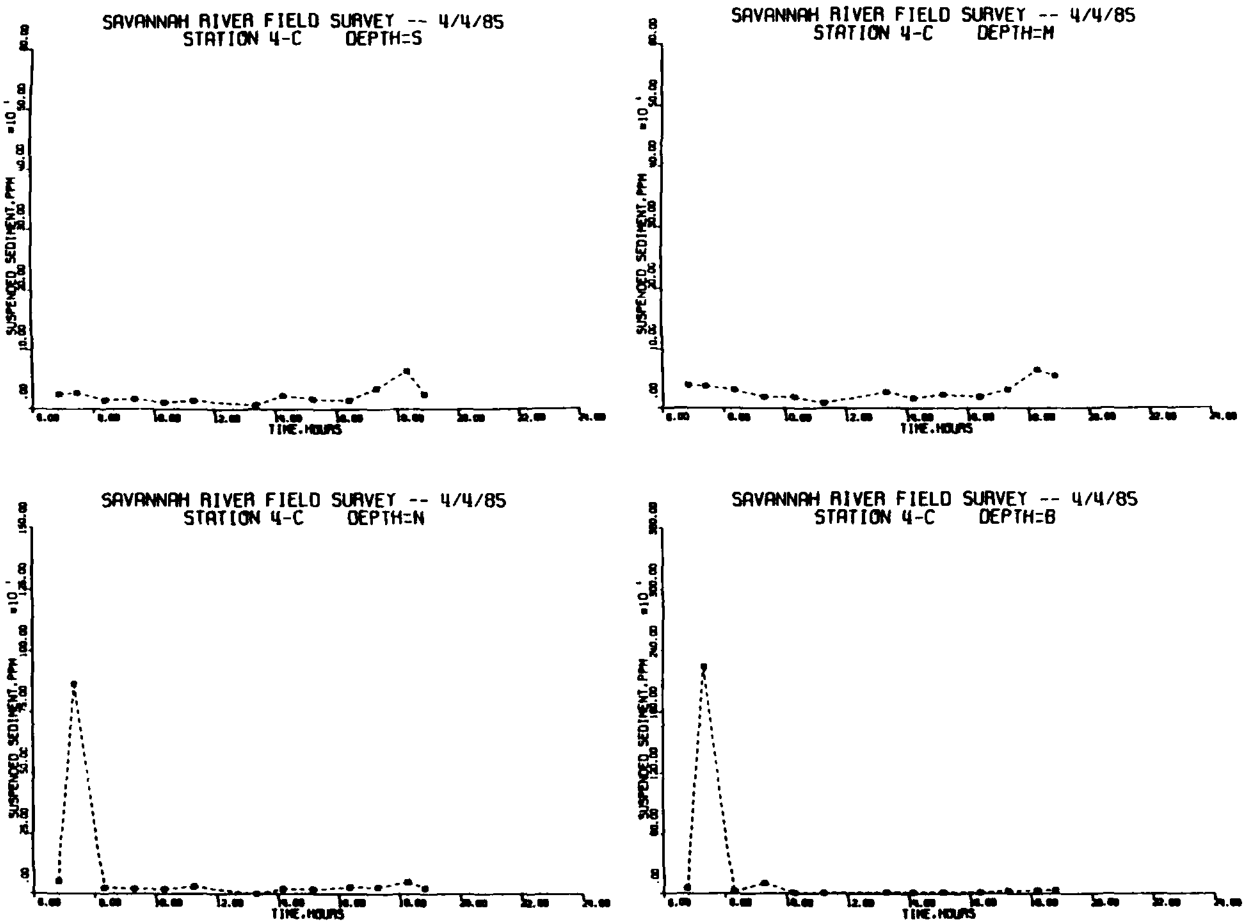


Figure D12. Suspended sediment at Range 4 on right prism line

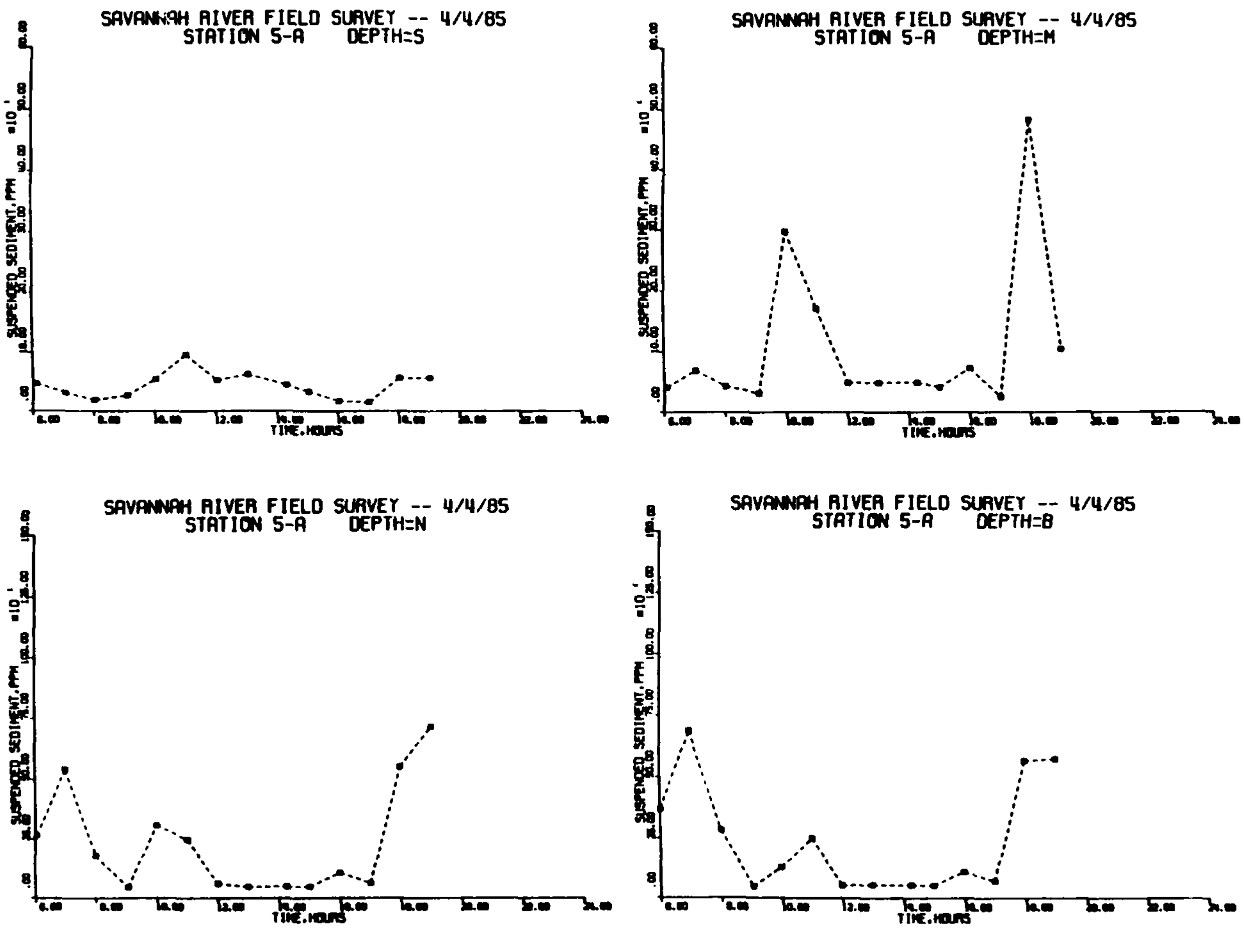


Figure D13. Suspended sediment at Range 5 on left prism line

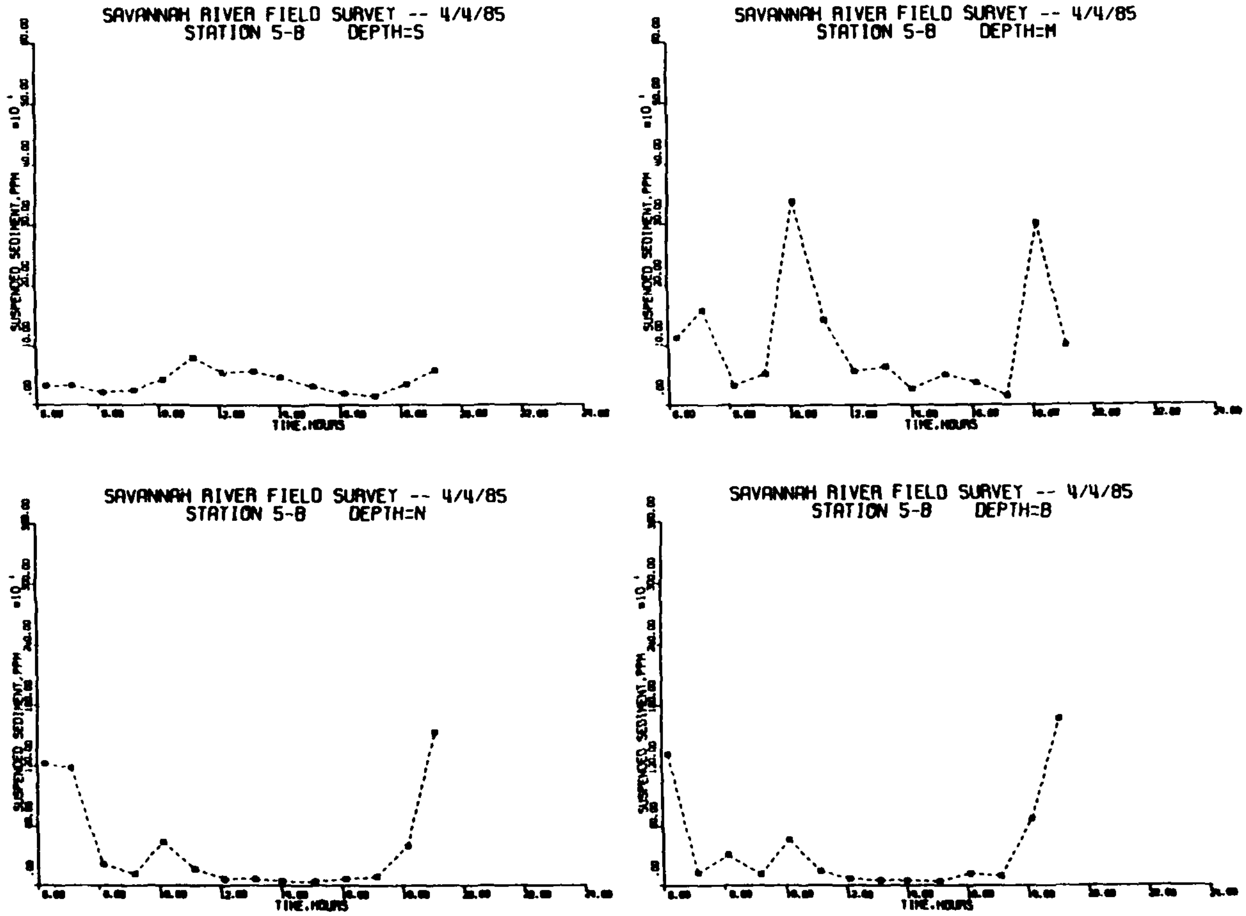


Figure D14. Suspended sediment at Range 5 in center of channel

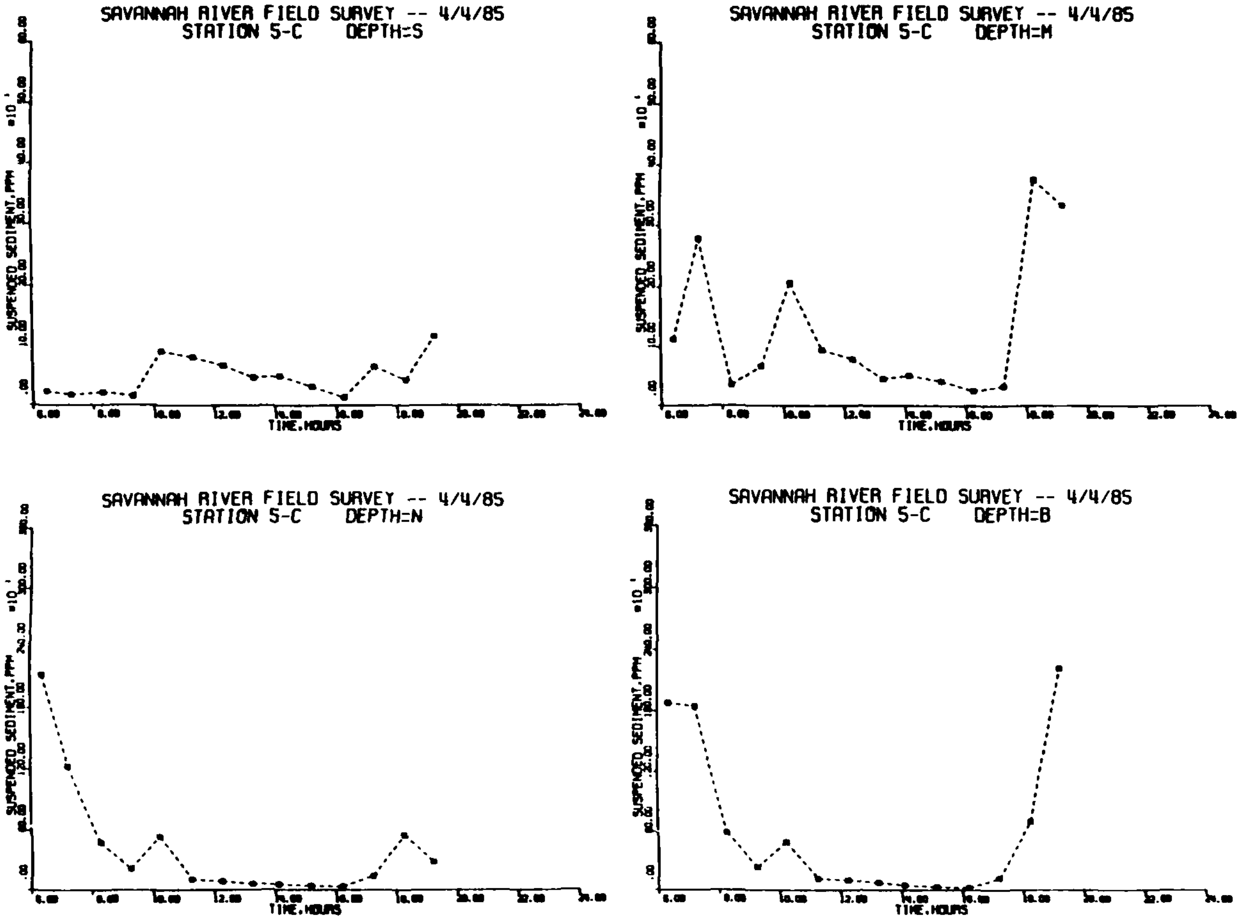


Figure D15. Suspended sediment at Range 5 on right prism line

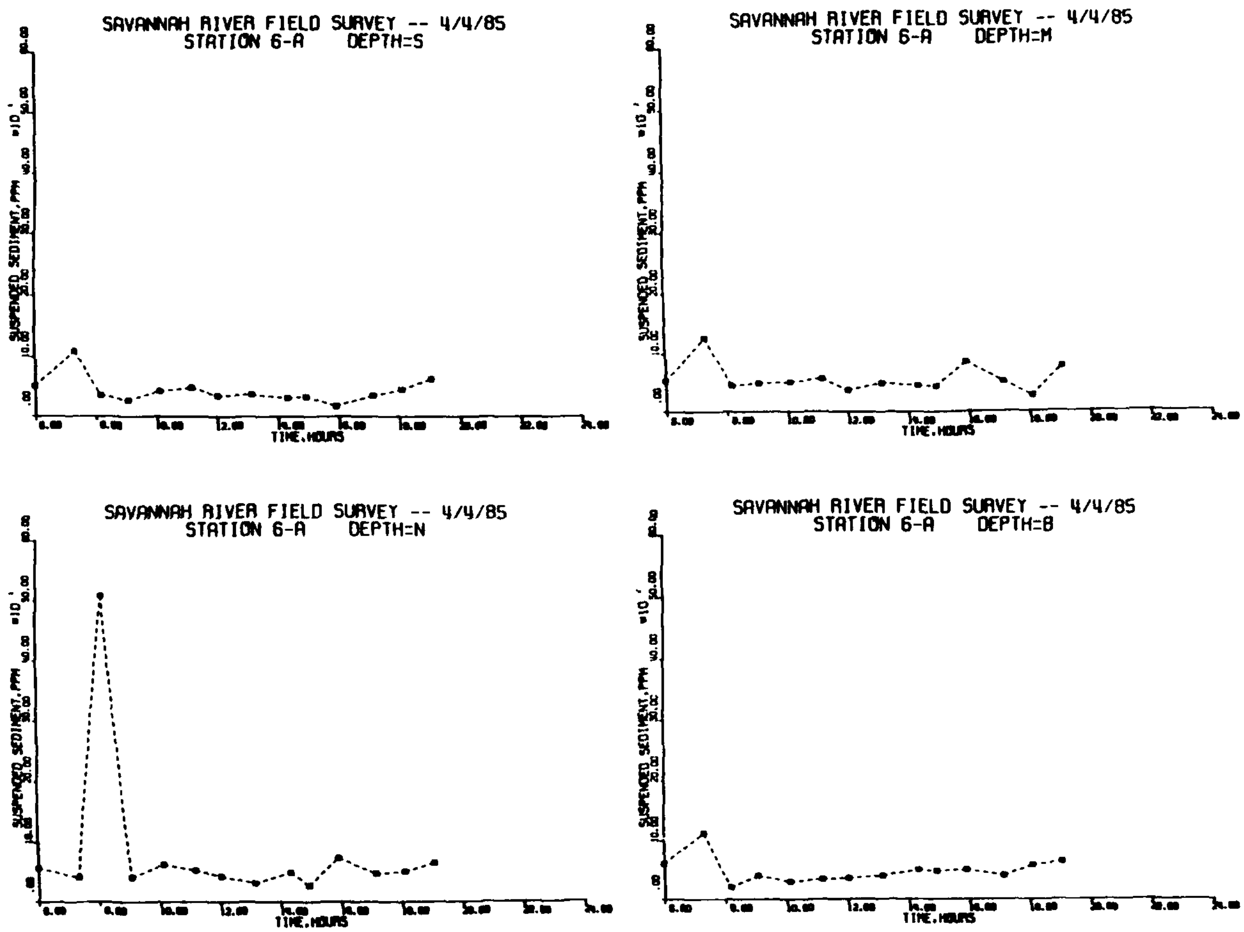


Figure D16. Suspended sediment at Range 6 on left prism line

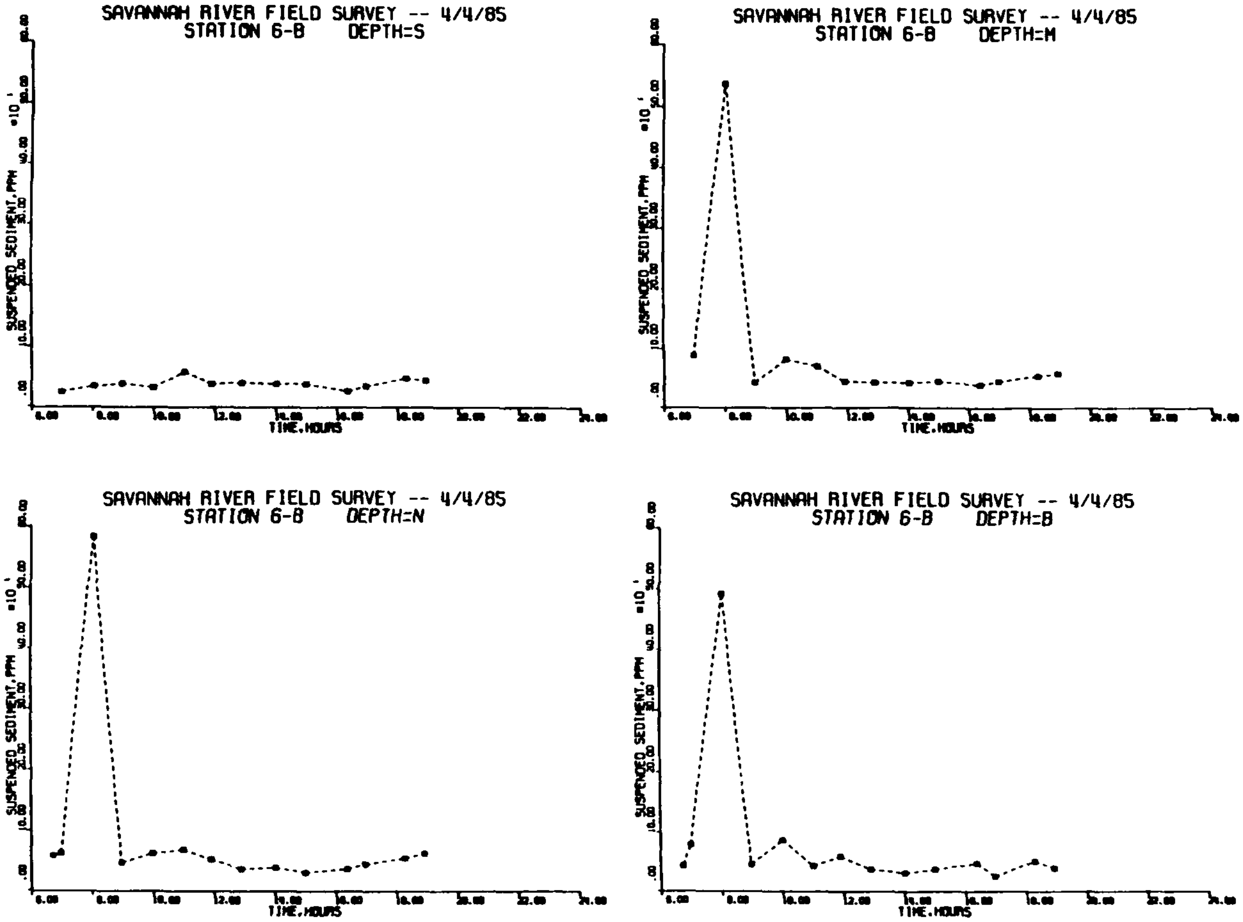


Figure D17. Suspended sediment at Range 6 in center of channel

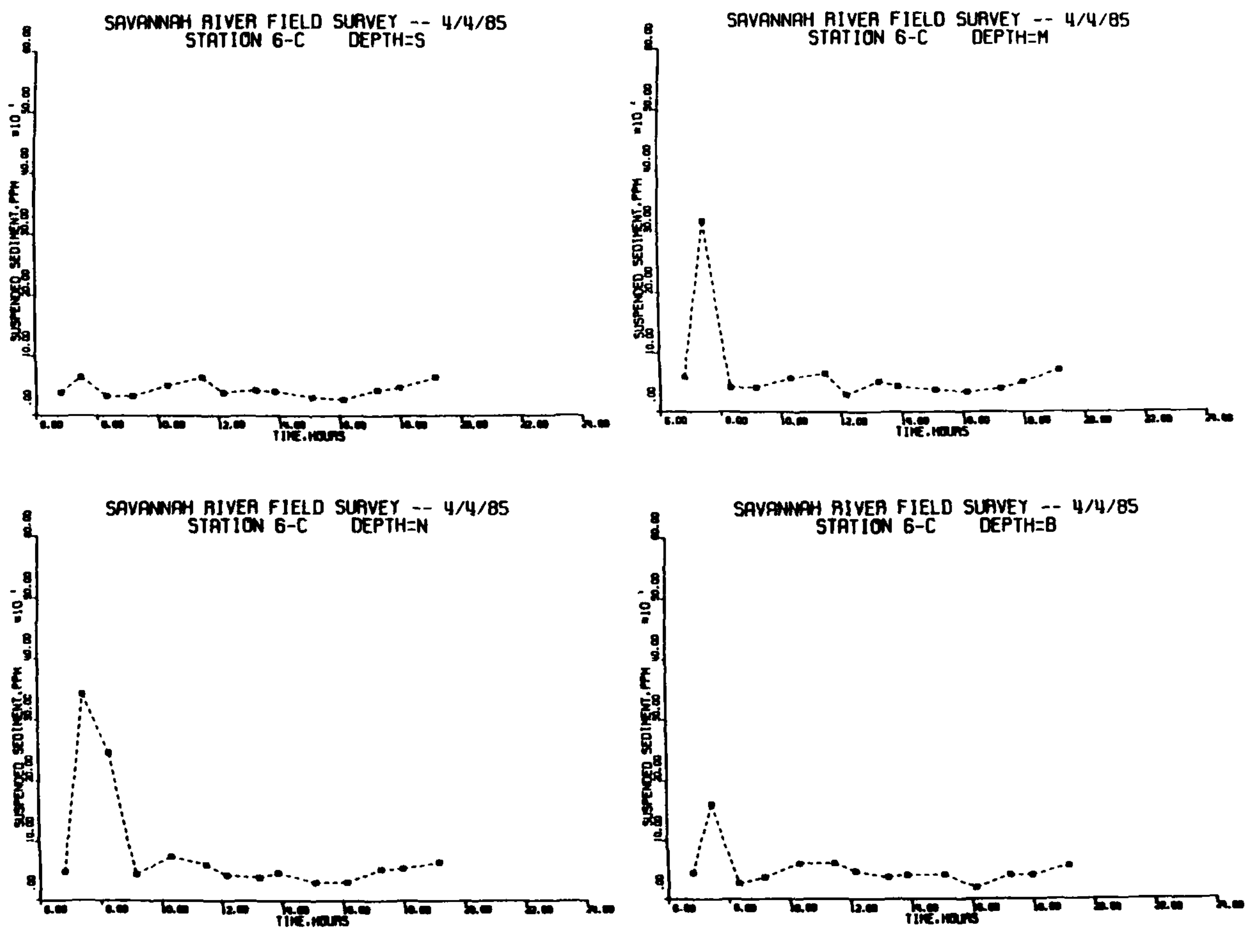


Figure D18. Suspended sediment at Range 6 on right prism line

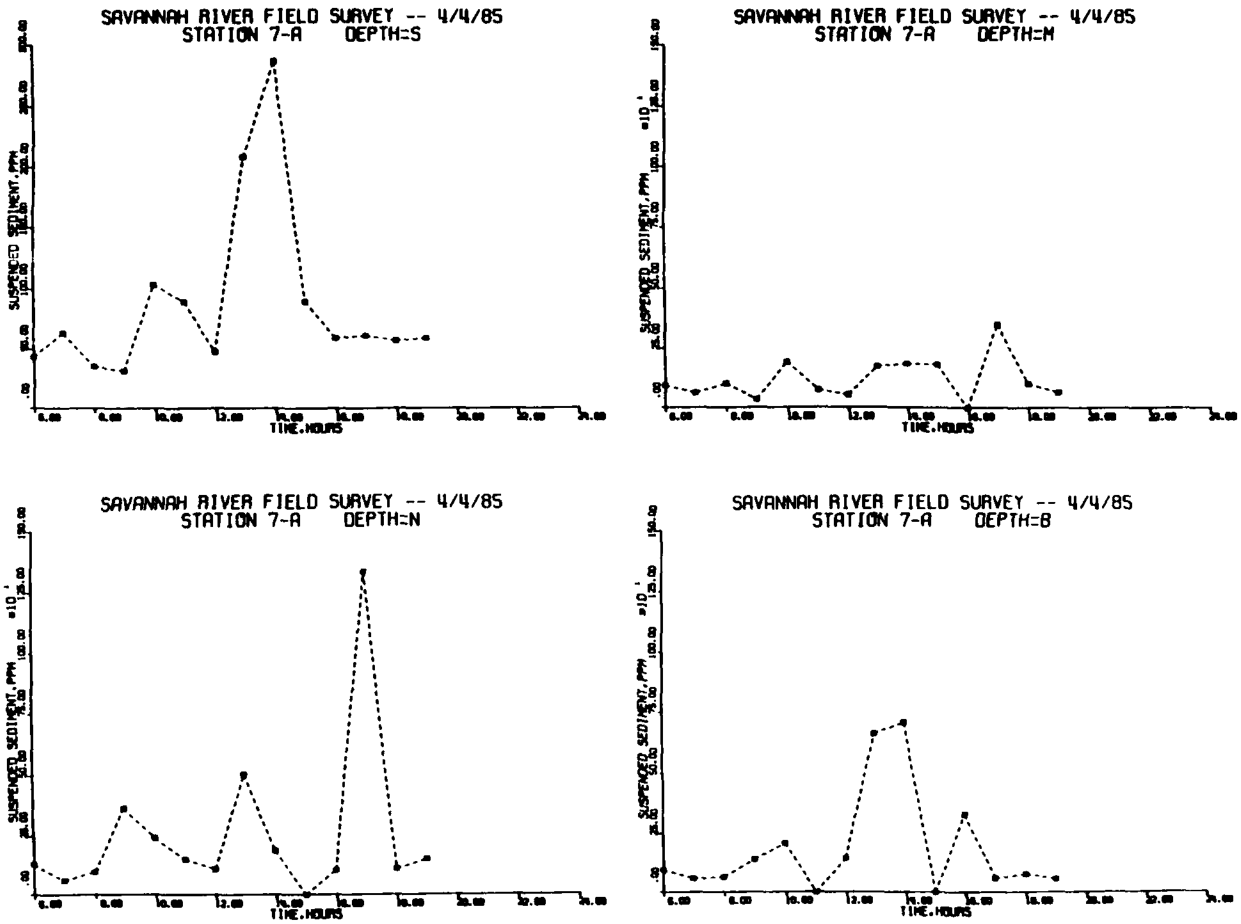


Figure D19. Suspended sediment at Range 7 on left prism line

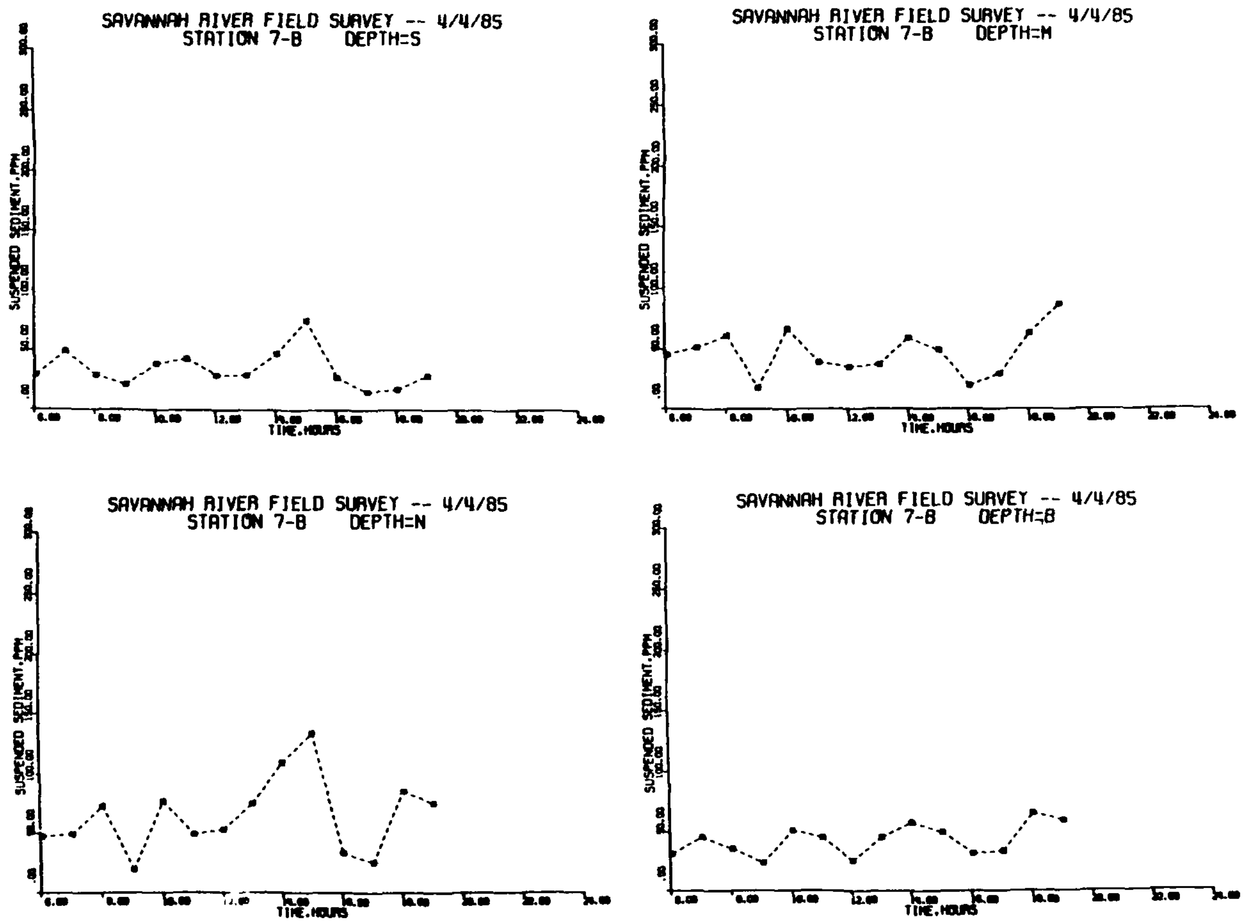


Figure D20. Suspended sediment at Range 7 in center of channel

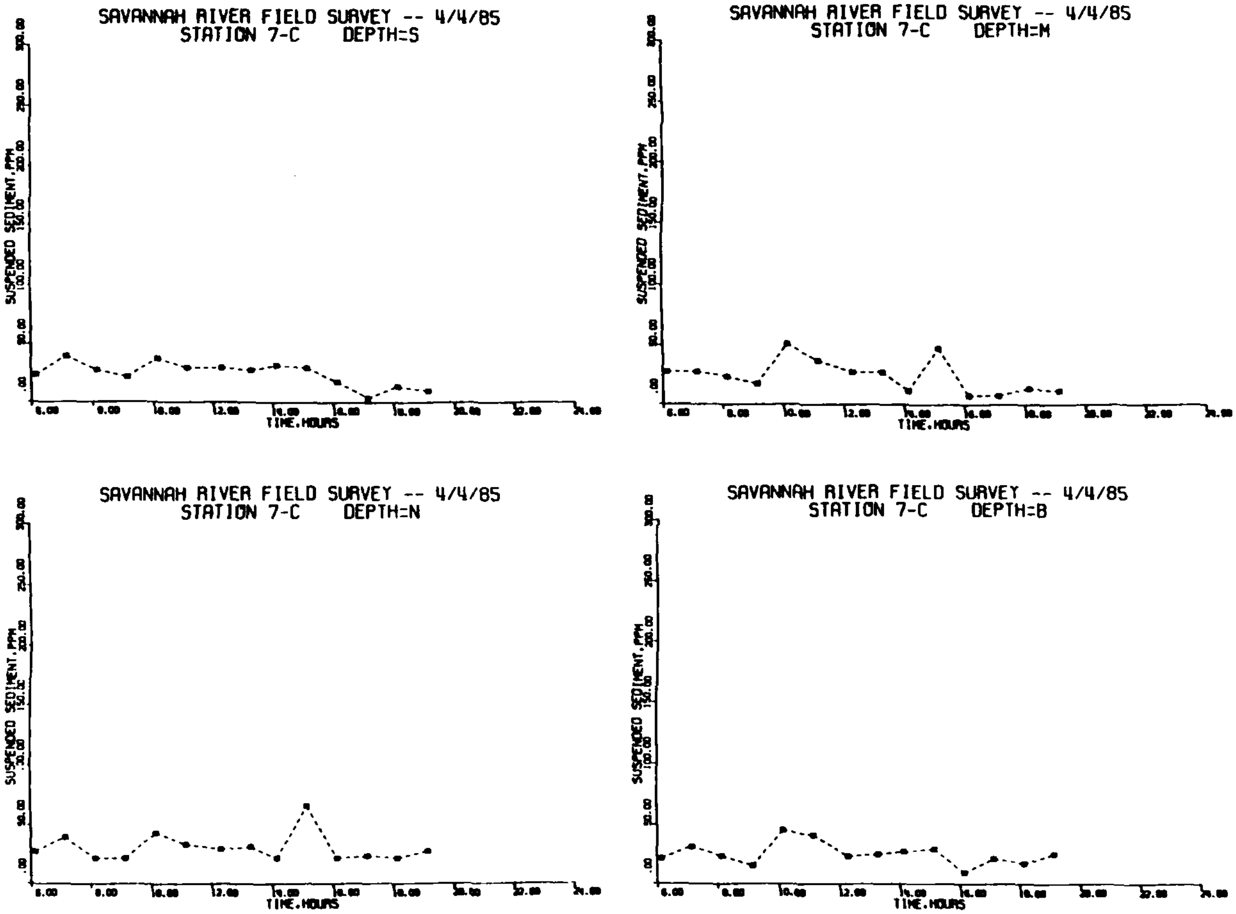


Figure D21. Suspended sediment at Range 7 on right prism line

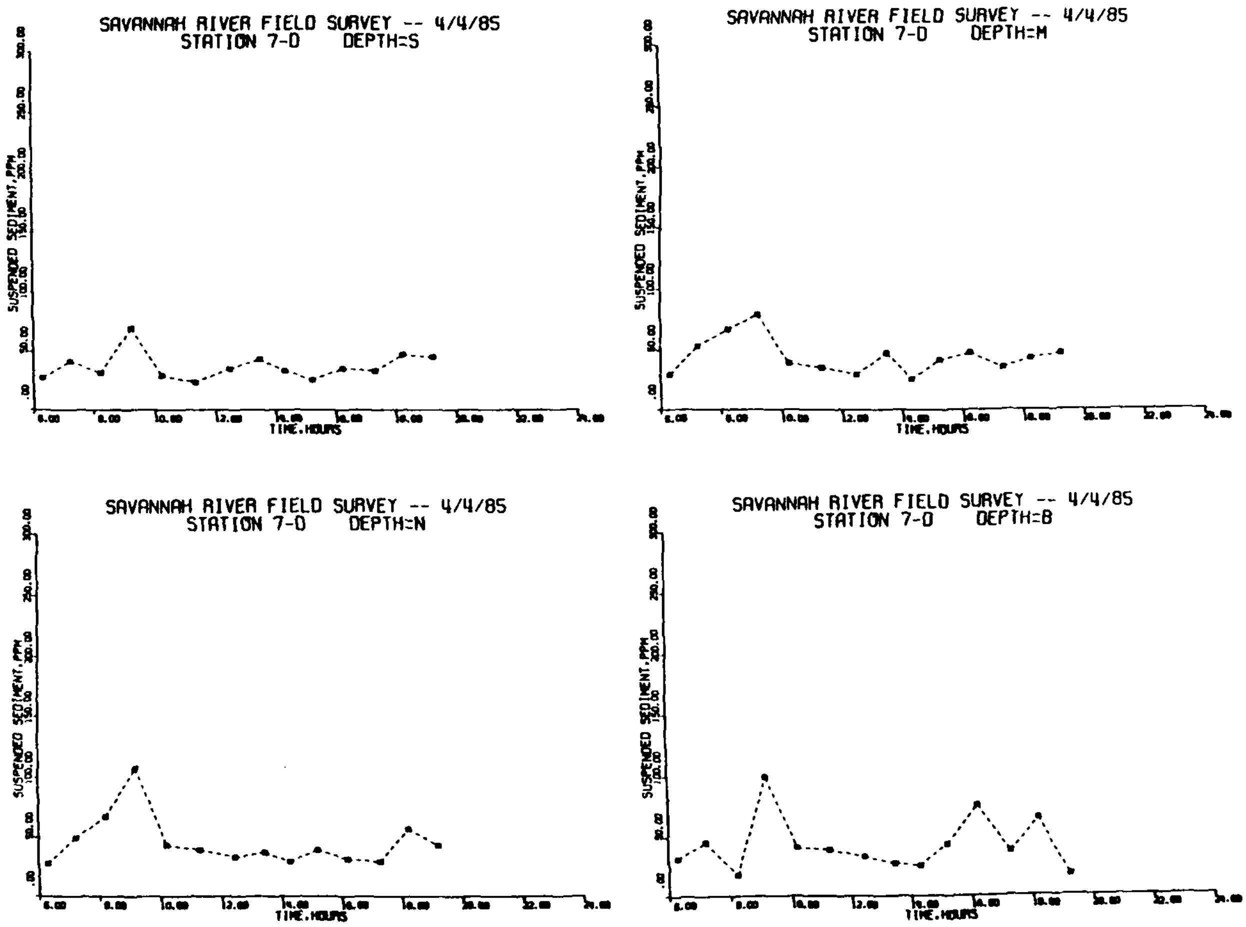


Figure D22. Suspended sediment at Range 7 in Middle River on left prism line

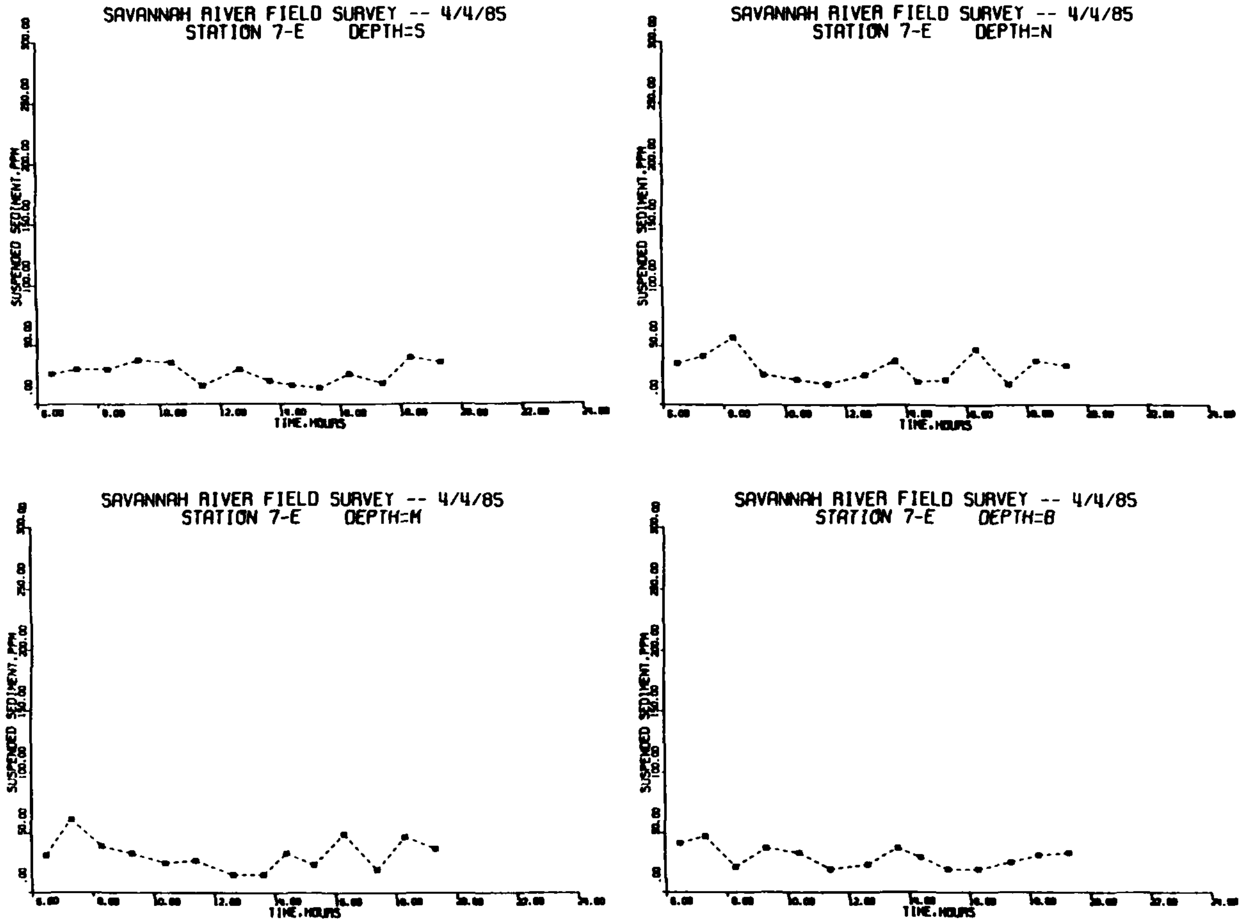


Figure D23. Suspended sediment at Range 7 in Middle River on right prism line

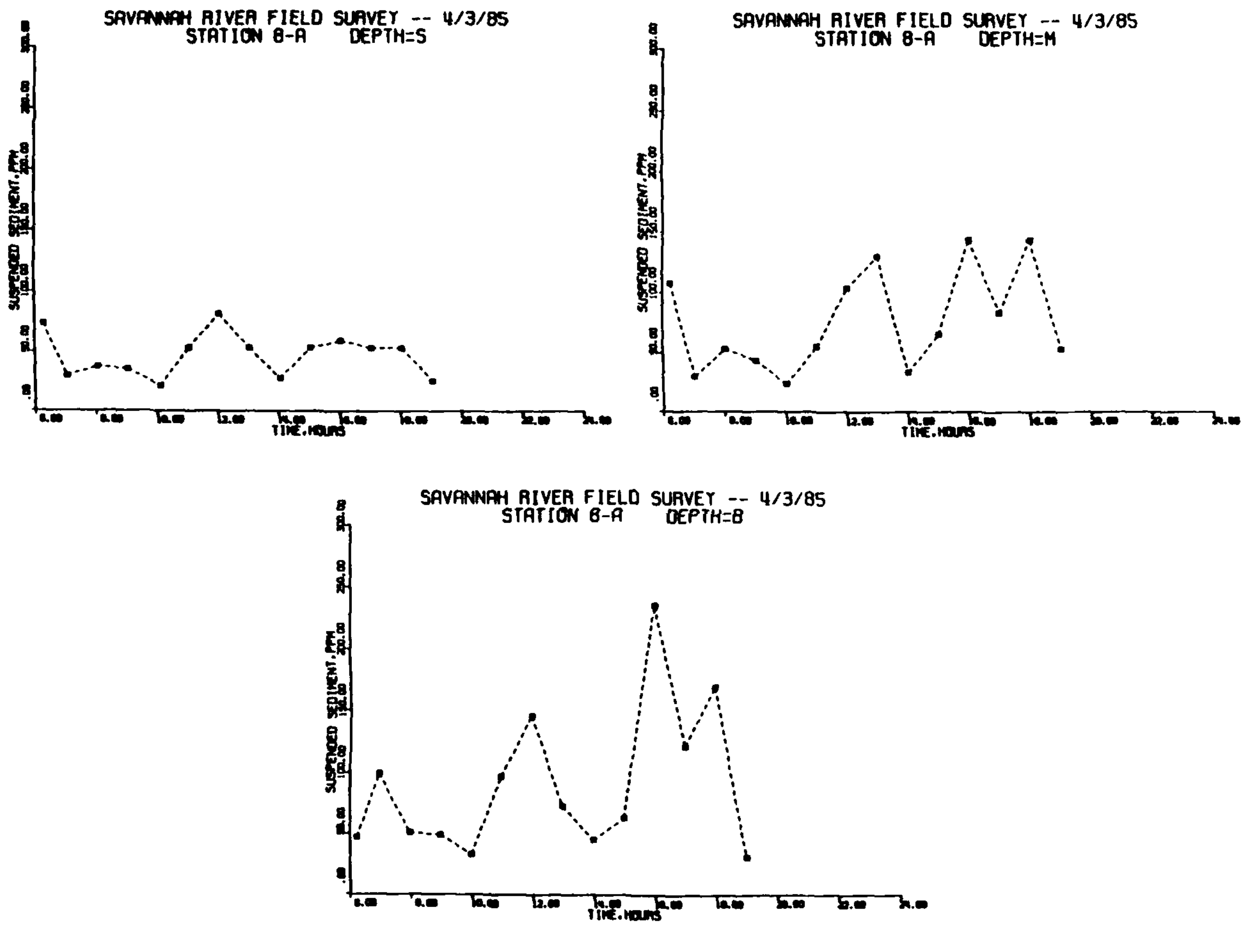


Figure D24. Suspended sediment at Range 8 at center of channel

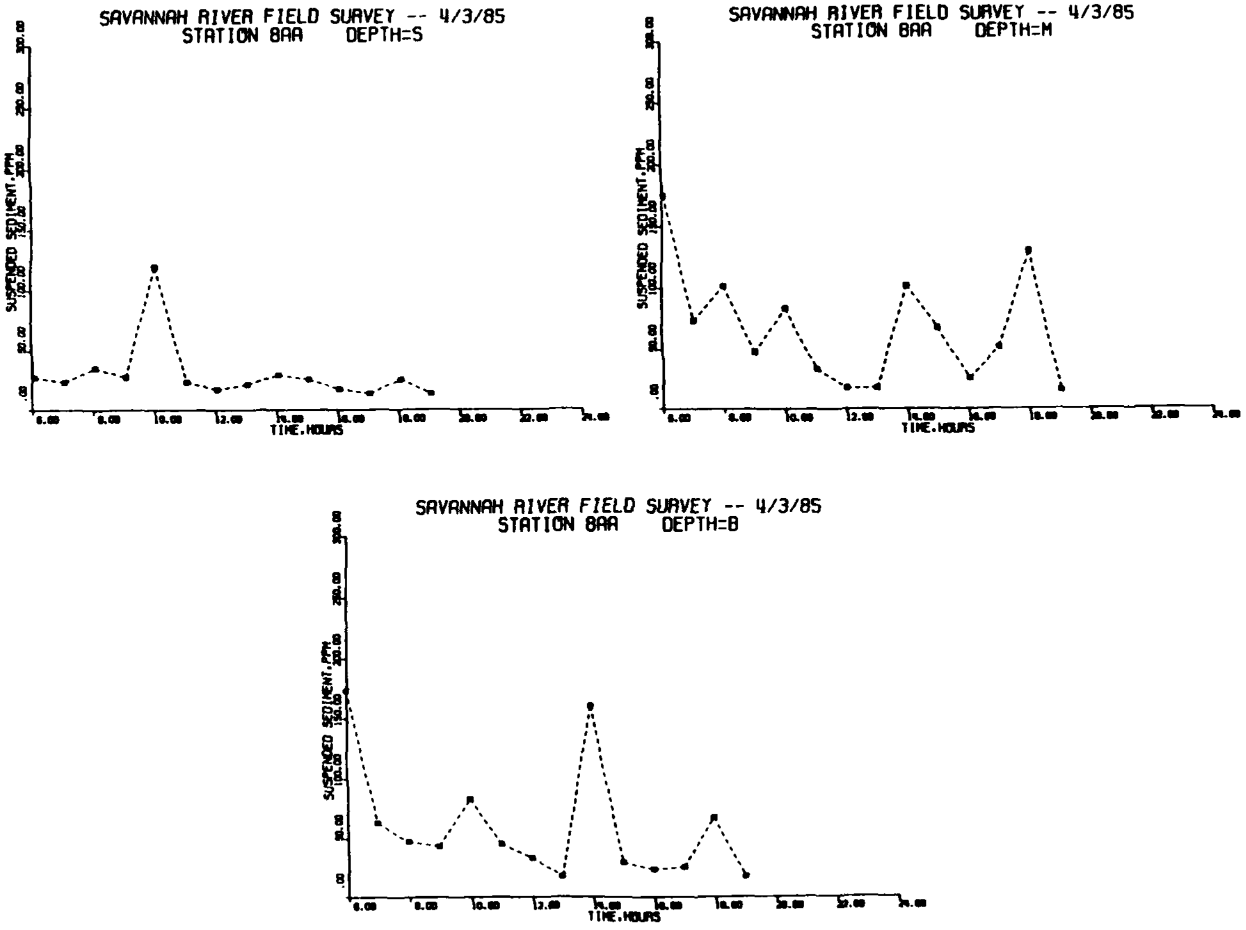


Figure D25. Suspended sediment at Range 8A at center of channel

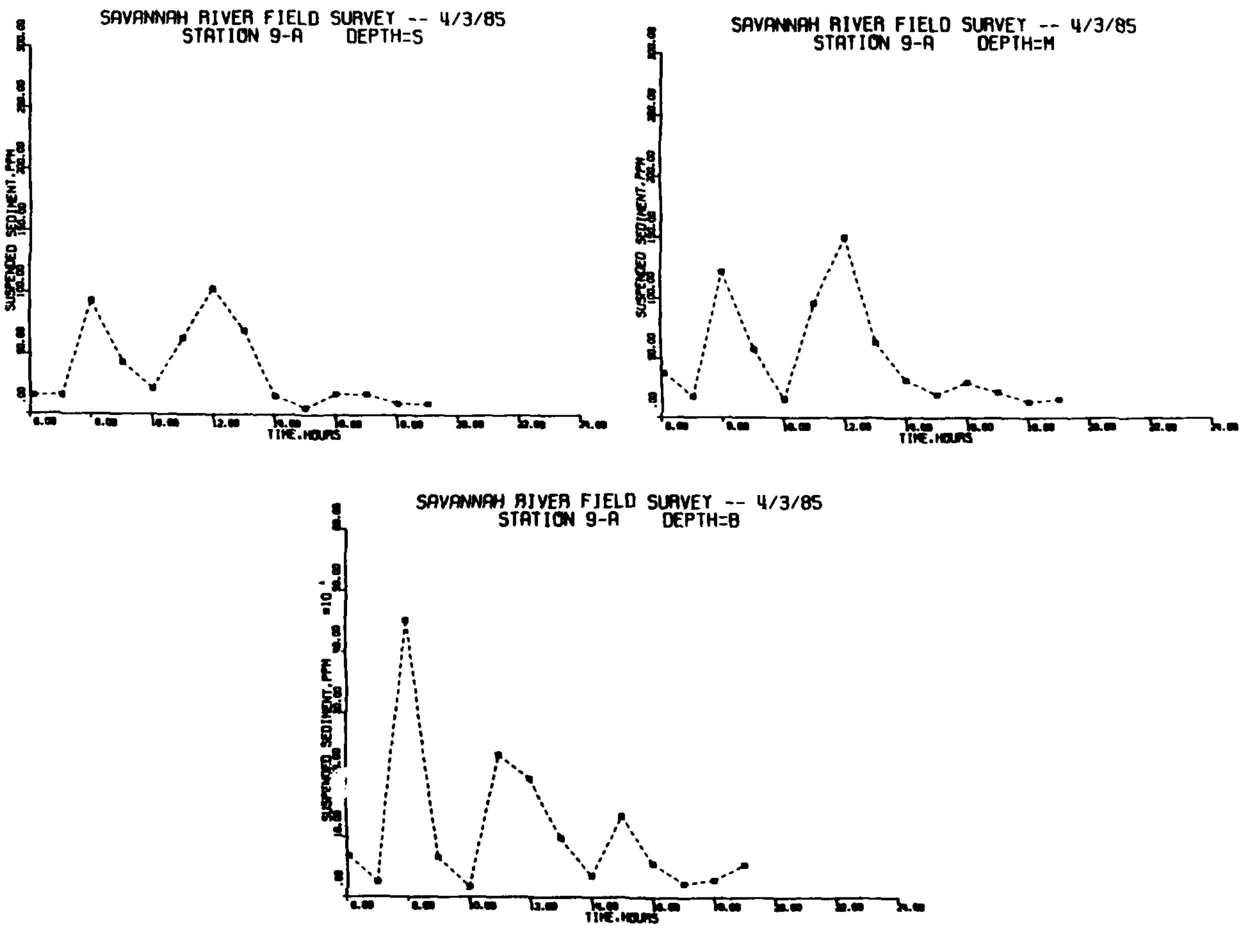


Figure D26. Suspended sediment at Range 9 in center of channel

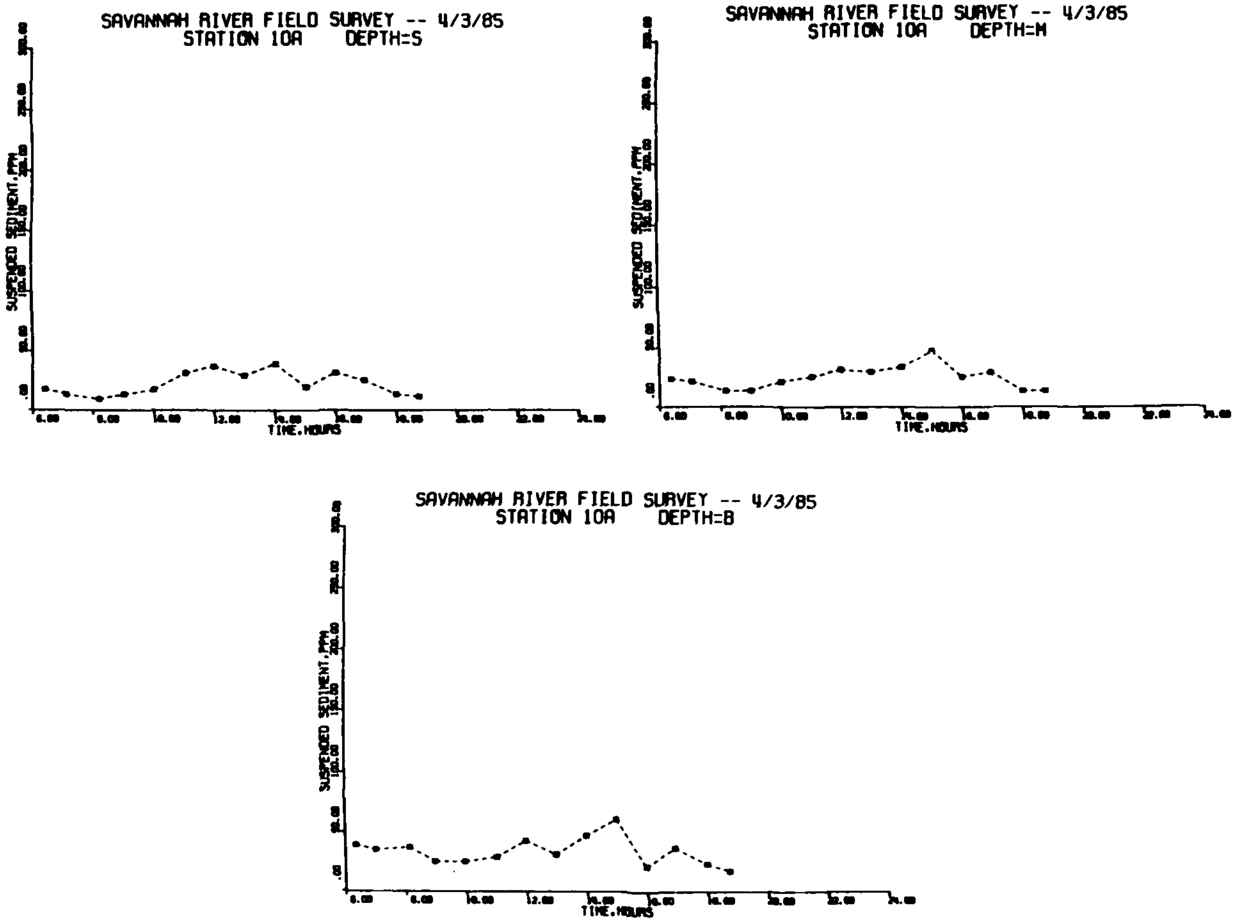


Figure D27. Suspended sediment at Range 10 in center of channel

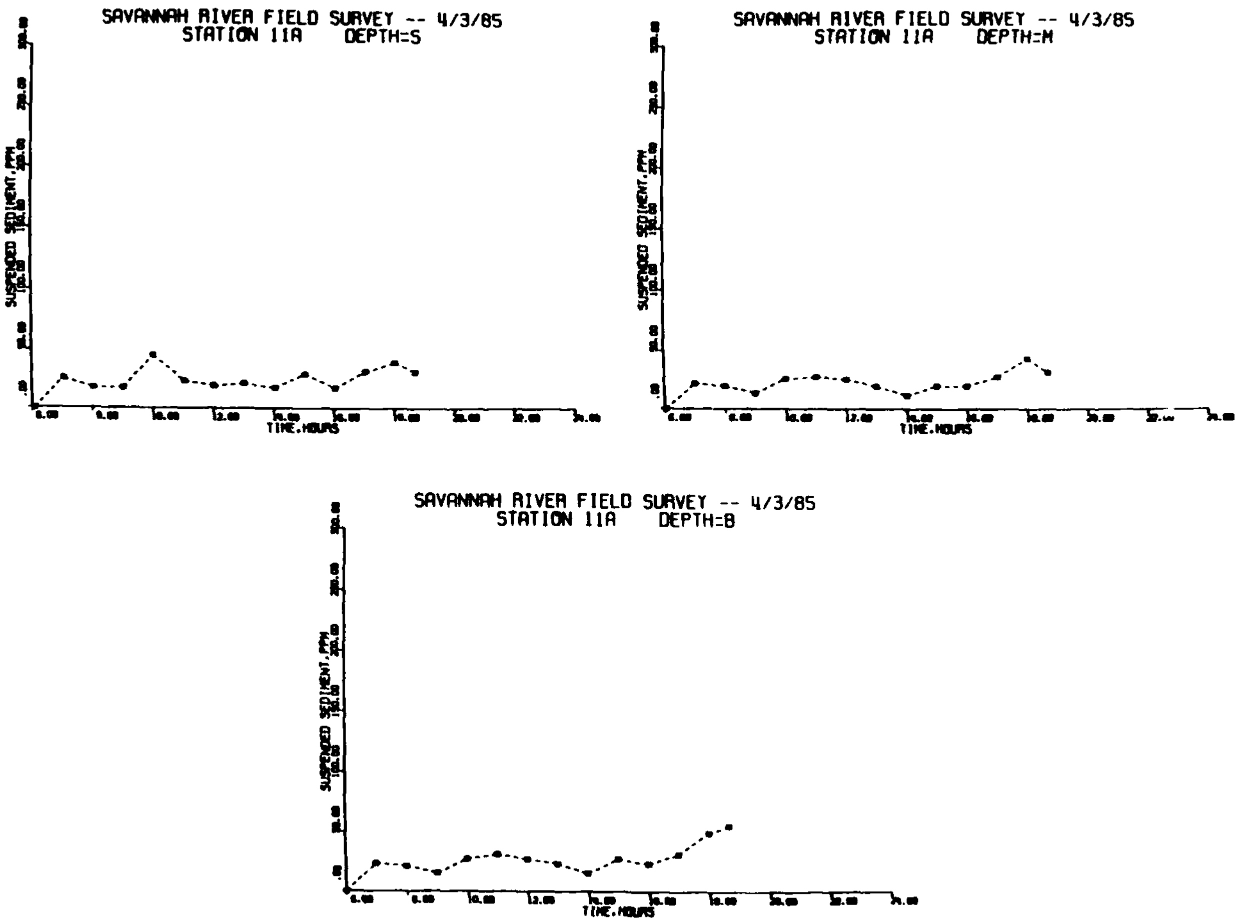


Figure D28. Suspended sediment at Range 11 in center of channel

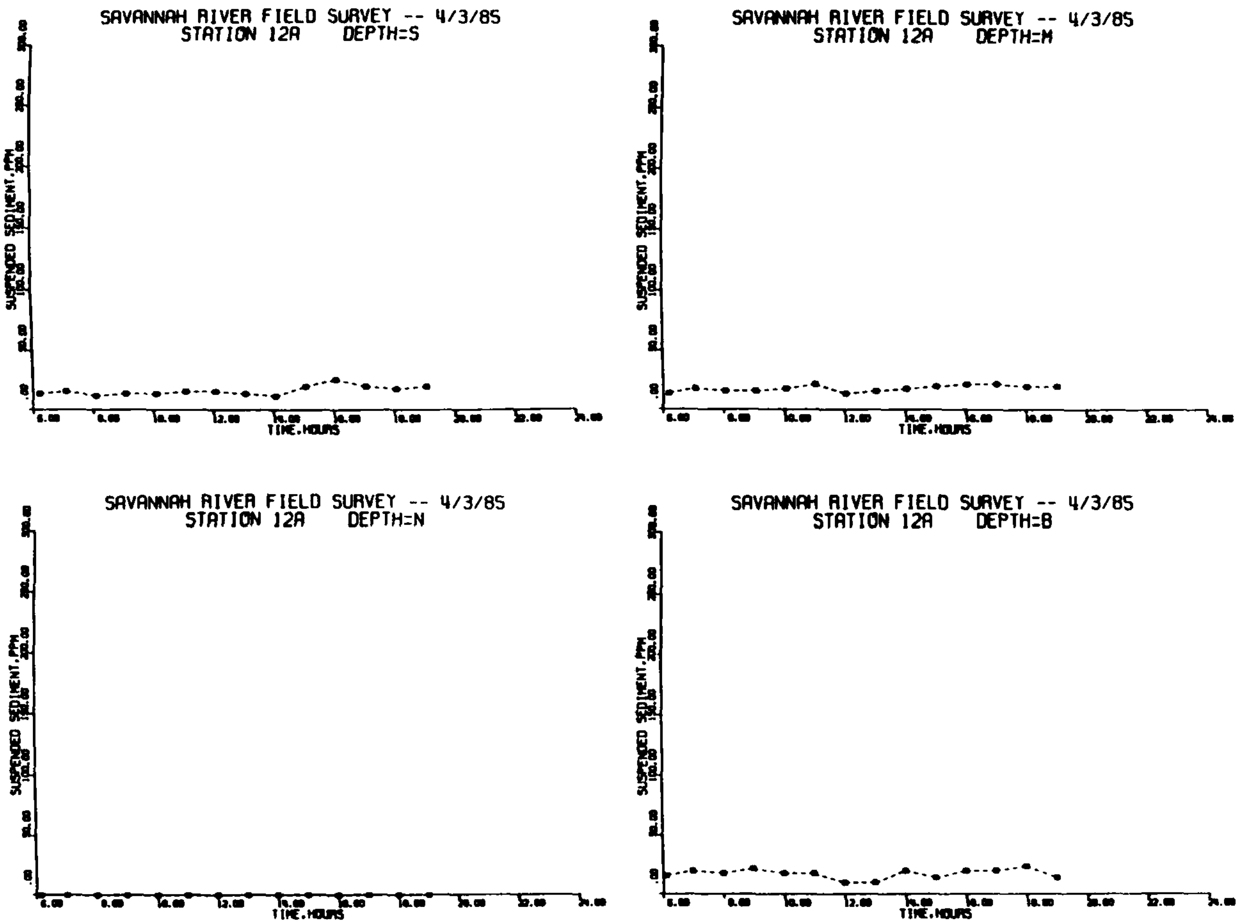
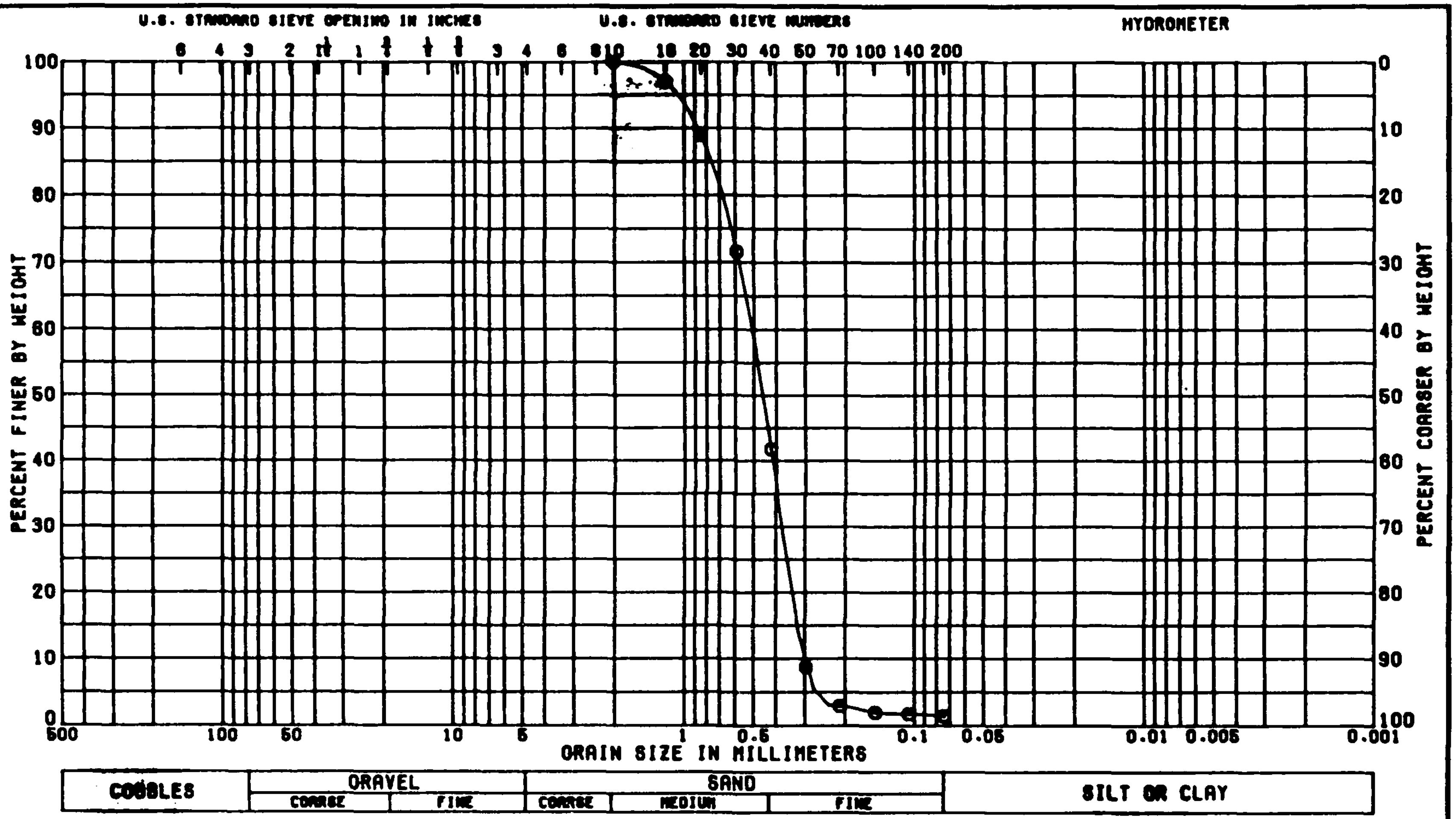


Figure D29. Suspended sediment at Range 12 in center of channel

APPENDIX E: BOTTOM SEDIMENT DATA

Bottom grab samples were collected using a mechanical claw at various locations in the estuary. These samples were then analyzed for grain size distribution. Gradation curves for 41 samples collected throughout the estuary are presented in Plates E1-E41.



LL	PL	PI	GS 2.66	NAT W.%	ORG: .5%

CLASSIFICATION

SAND (SP), BROWN

GRADATION CURVE

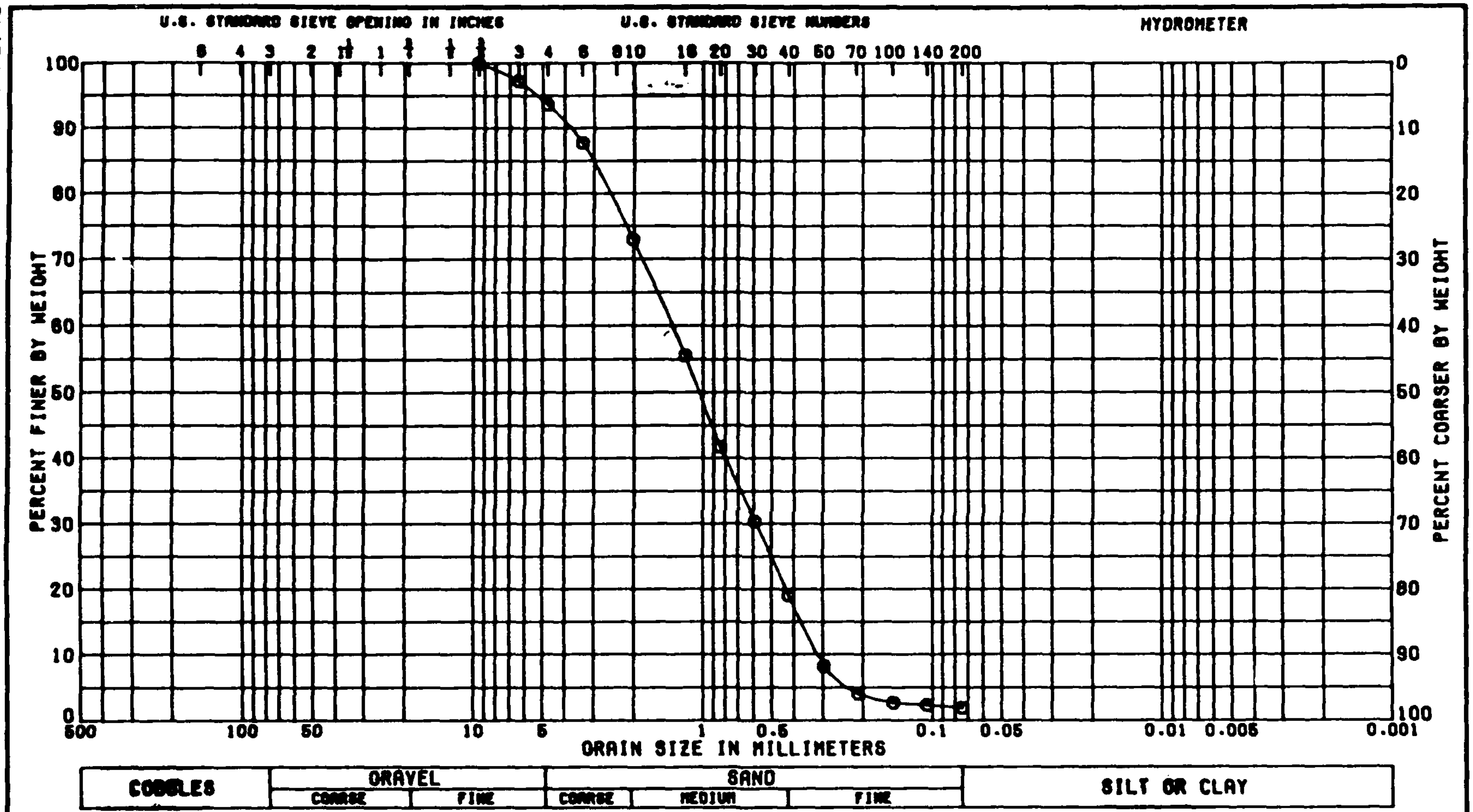
PROJECT SAVANNAH HARBOR

MIDDLE RIVER

BORING NO. 0 SAMPLE NO. 50

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E1



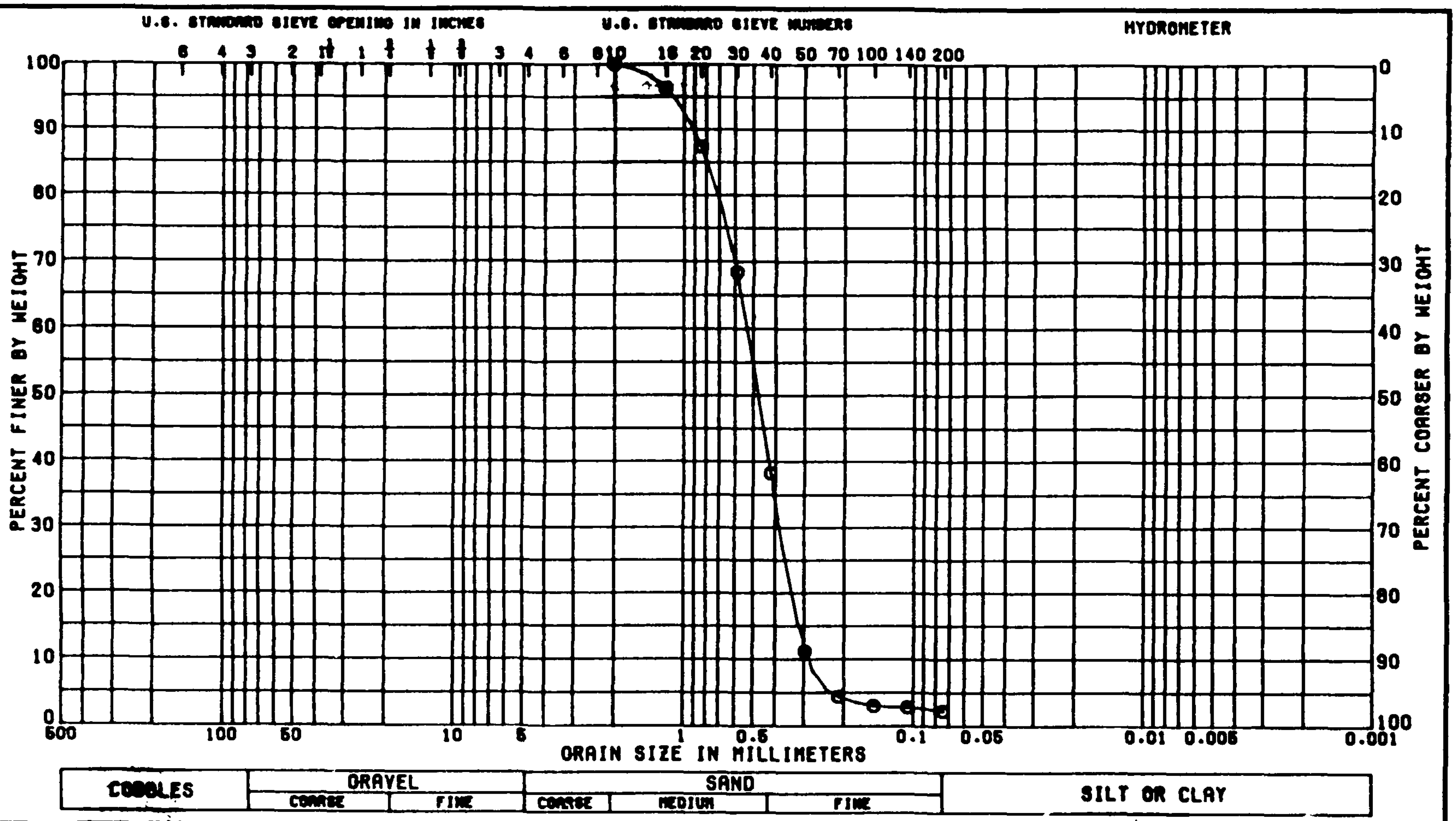
LL	PL	PI	GS 2.64	NAT W.%	ORG: 1.0%

CLASSIFICATION
SAND (SP), BROWN

GRADATION CURVE

PROJECT SAVANNAH HARBOR
LITTLE BACK RIVER
BORING NO. 0 SAMPLE NO. 51
DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E2

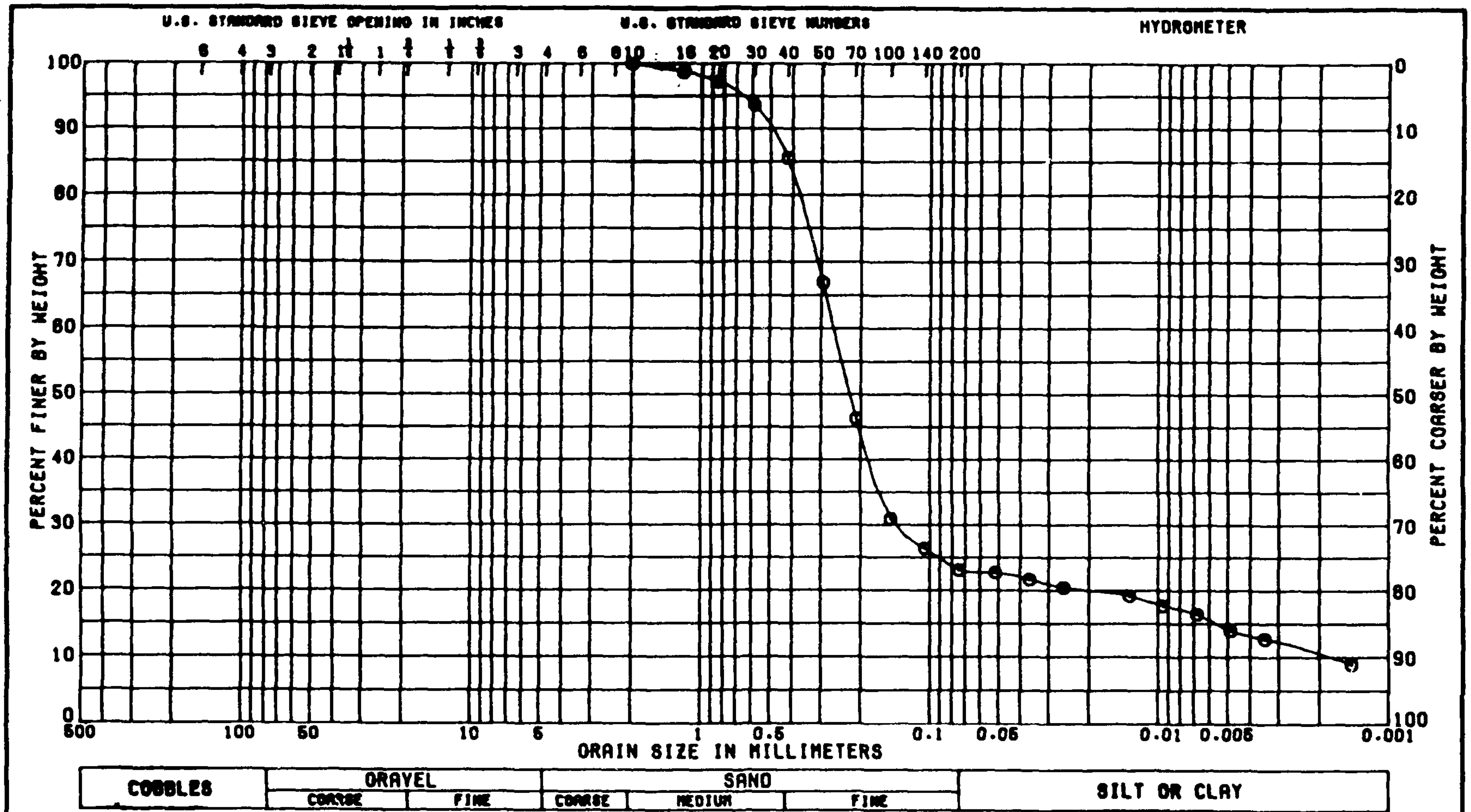


LL	PL	PI	GS 2.65	NAT W.%	ORG: .5%

CLASSIFICATION
SAND (SP), BROWN

PROJECT SAVANNAH HARBOR
LITTLE BACK RIVER
BORING NO. 0 SAMPLE NO. 52
DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE



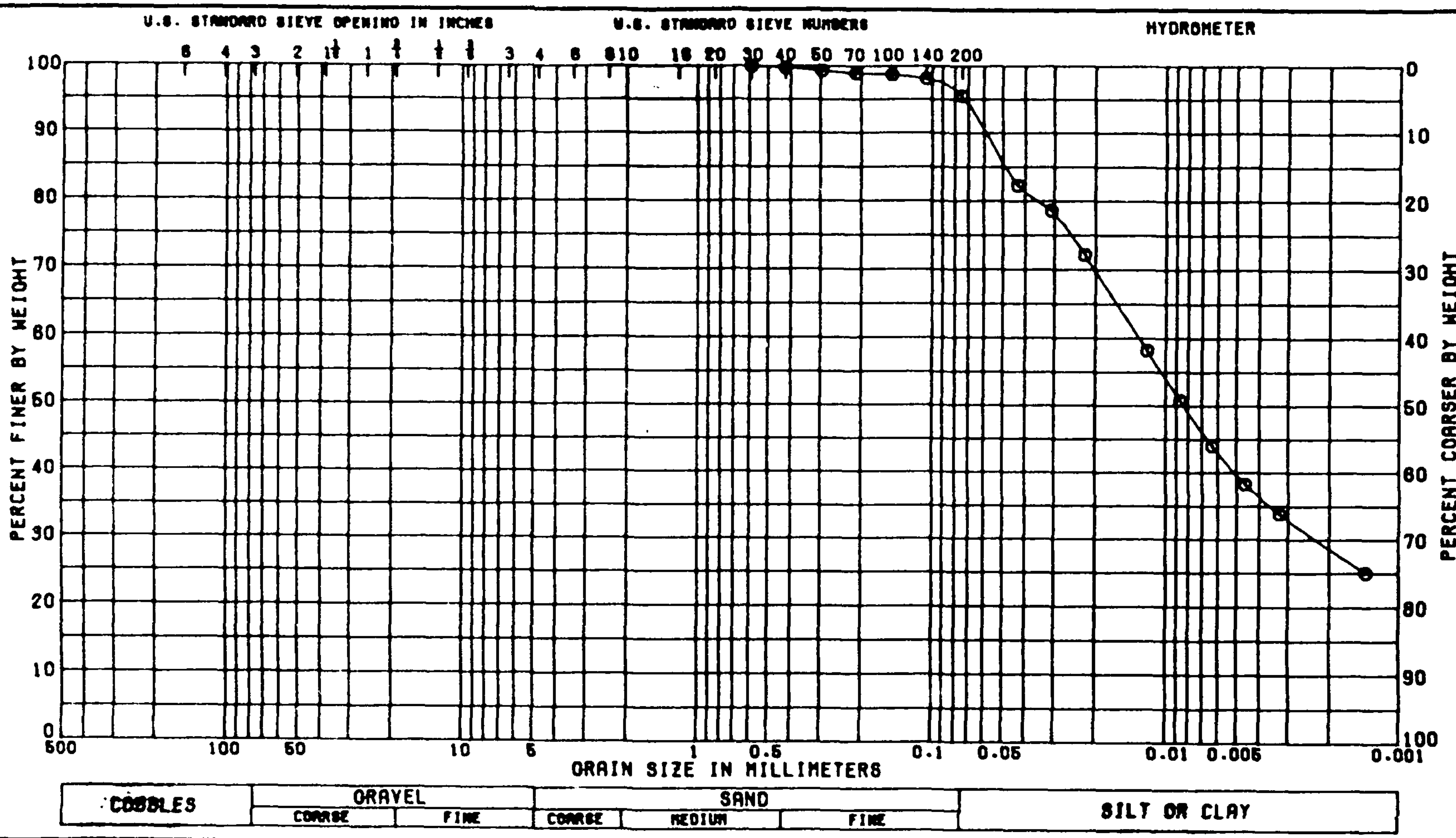
LL	PL	PI	GS 2.65 EST	NAT W.%	

CLASSIFICATION
CLAYEY SAND (SC), GRAY

GRADATION CURVE

PROJECT SAVANNAH HARBOR
BACK RIVER
BORING NO. 0 SAMPLE NO. 53
DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E4



LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION

CLAY (CL), GRAY: TRACE OF SAND

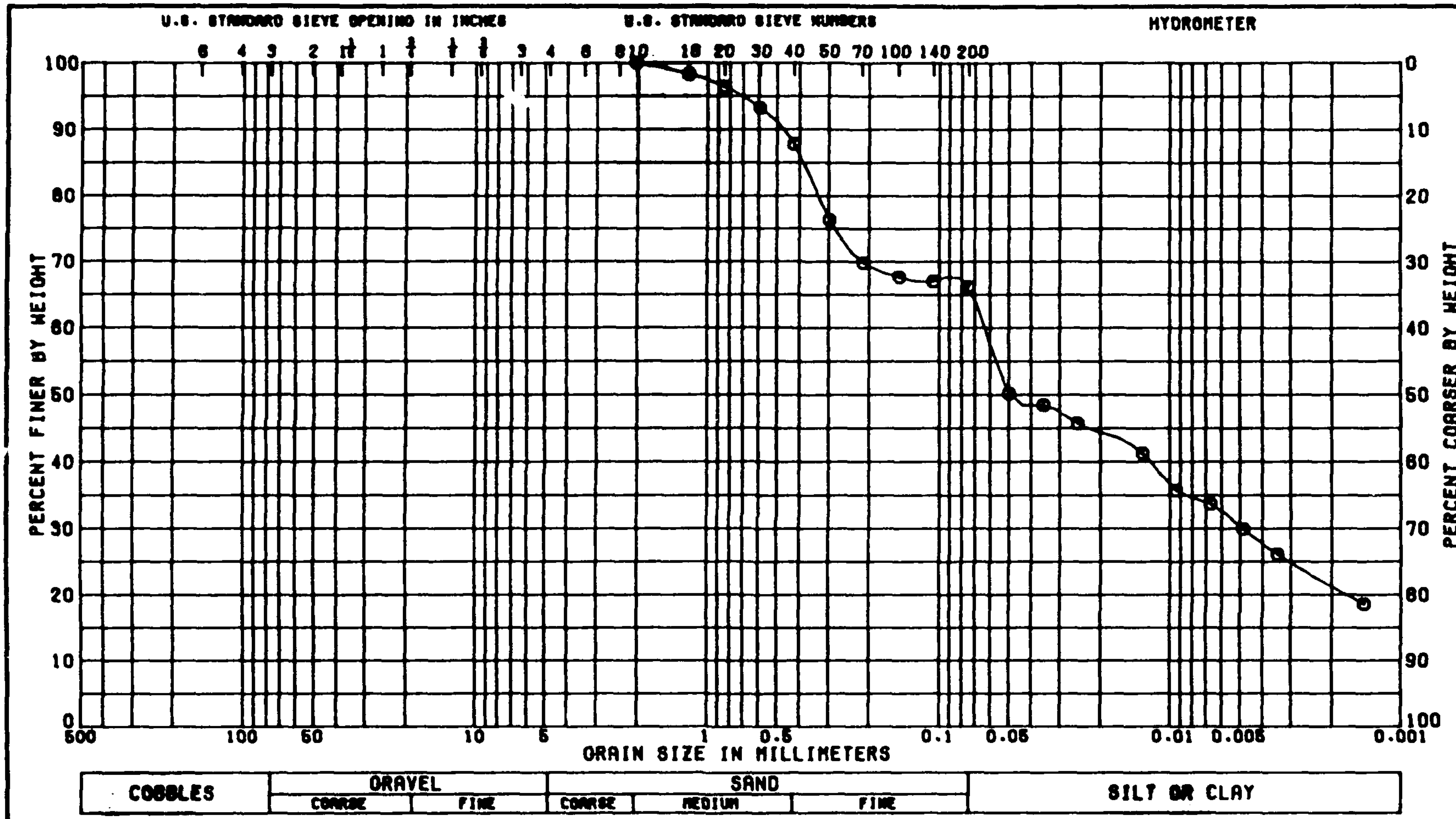
GRADATION CURVE

PROJECT SAVANNAH HARBOR

BACK RIVER

BORING NO. 0 SAMPLE NO. 54

DEPTH/ELEV 0 DATE 12 JUL 85



LL	PL	PI	GS 2.60 EST	NAT W.%	ORG: 8.7%

CLASSIFICATION
SANDY SILT (ML), BROWN

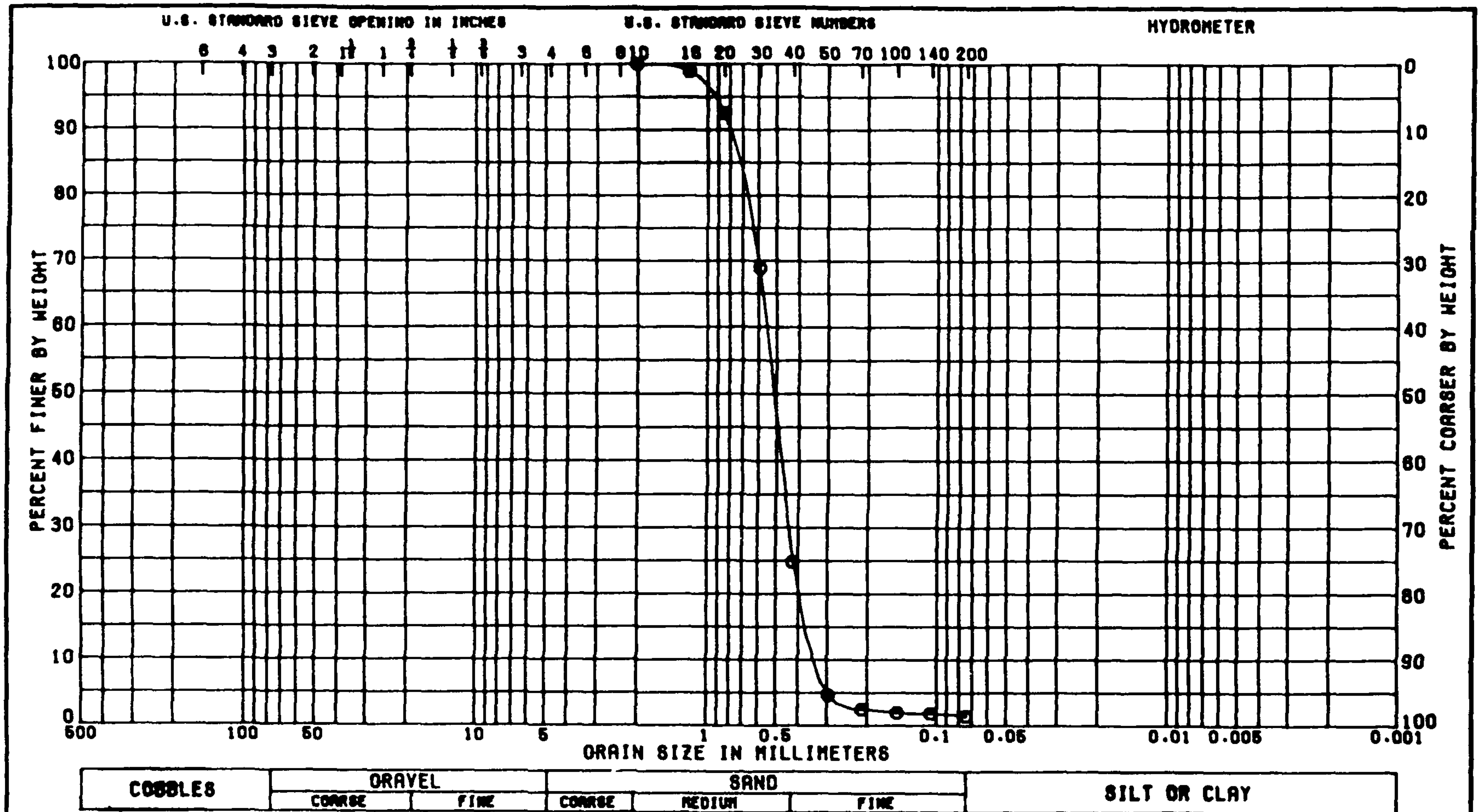
PROJECT SAVANNAH HARBOR
BACK RIVER

BORING NO. 0 SAMPLE NO. 55

DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE

PLATE E6

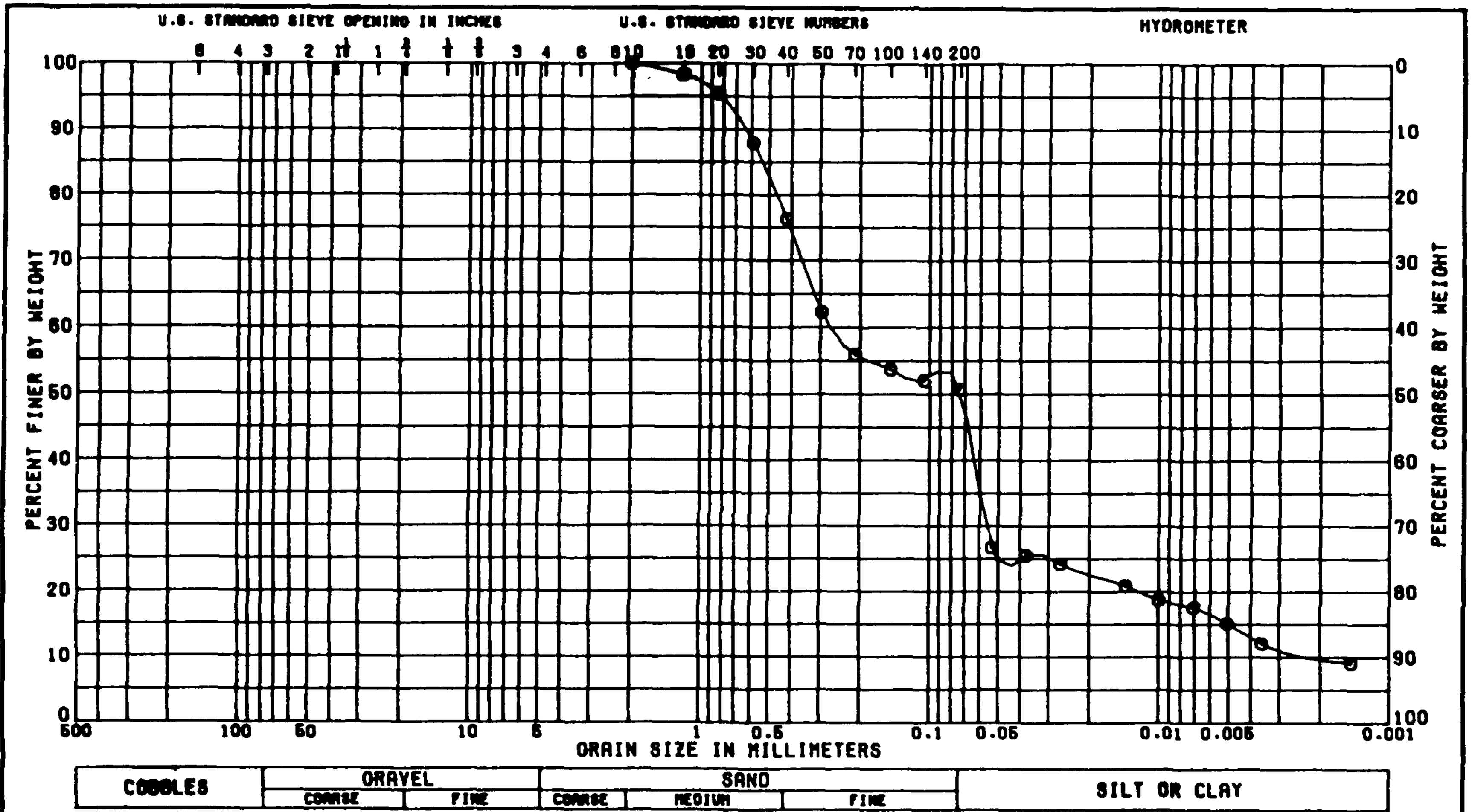


LL	PL	PI	GS 2.65	NAT W.%	ORG: .2%

CLASSIFICATION
SAND (SP), BROWN

GRADATION CURVE

PROJECT SAVANNAH HARBOR
MIDDLE RIVER
BORING NO. 0 SAMPLE NO. 56
DEPTH/ELEV 0 DATE 12 JUL 85



LL	PL	PI	GS 2.58	NAT W.%	ORG: 6.5%

CLASSIFICATION
SANDY CLAY (CL), GRAY

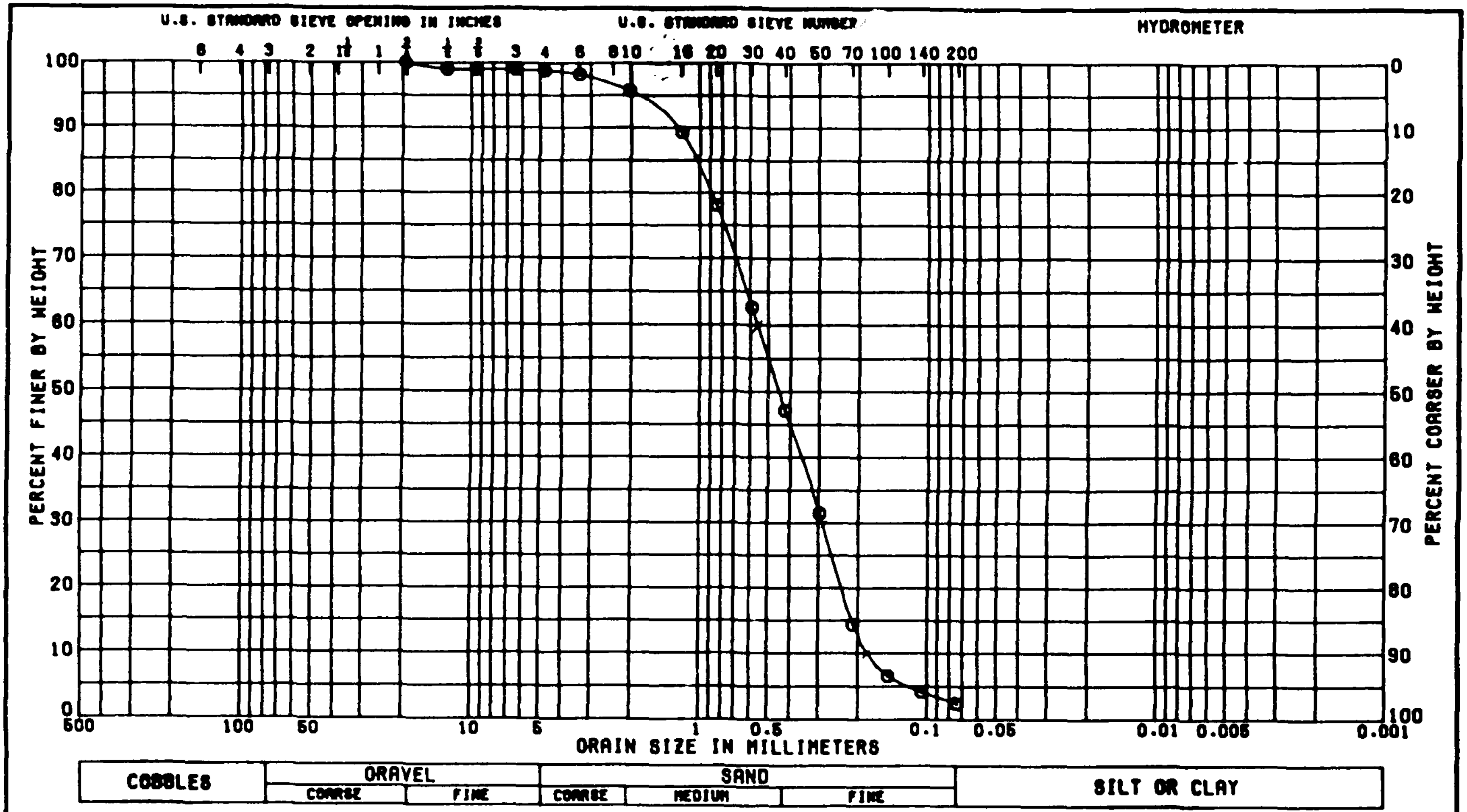
GRADATION CURVE

PROJECT SAVANNAH HARBOR
WHITEHALL CHANNEL

BORING NO. 0 SAMPLE NO. 57

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E8

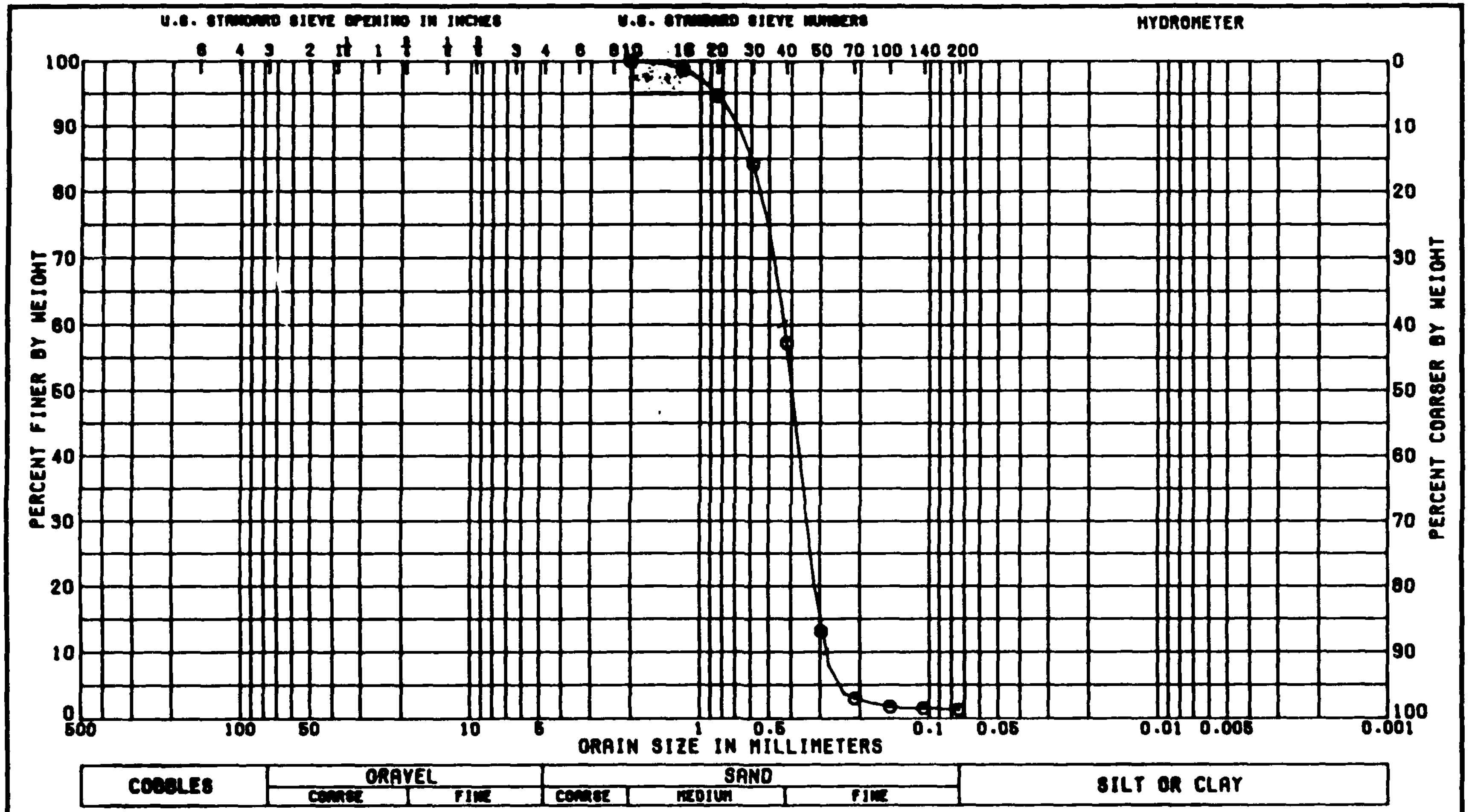


LL	PL	PI	GS	NAT W.%	

CLASSIFICATION
SAND (SP), BROWN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT SAVANNAH HARBOR
RIVER MILE 27.5
BORING NO. 0 SAMPLE NO. 58
DEPTH/ELEV 0 DATE 12 JUL 85



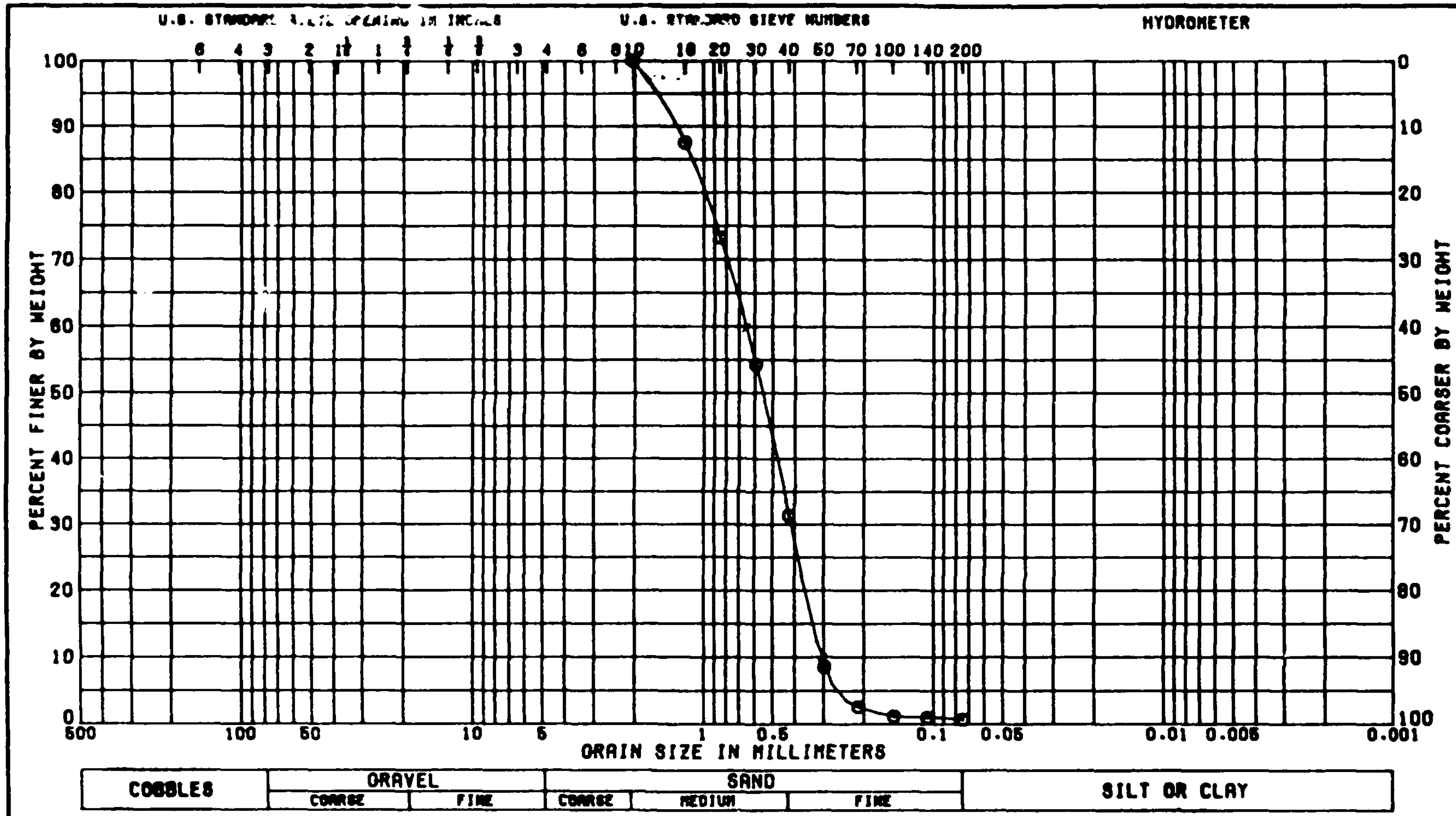
LL	PL	PI	GS	NAT W.%	

CLASSIFICATION SAND (SP), BROWN

PROJECT SAVANNAH HARBOR
RIVER MILE 30.8
BORING NO. 0 SAMPLE NO. 59
DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE

PLATE E10



LL	PL	PI	GS 2.65	NAT W.%	ORG: .7%

CLASSIFICATION

SAND (SP), BROWN

GRADATION CURVE

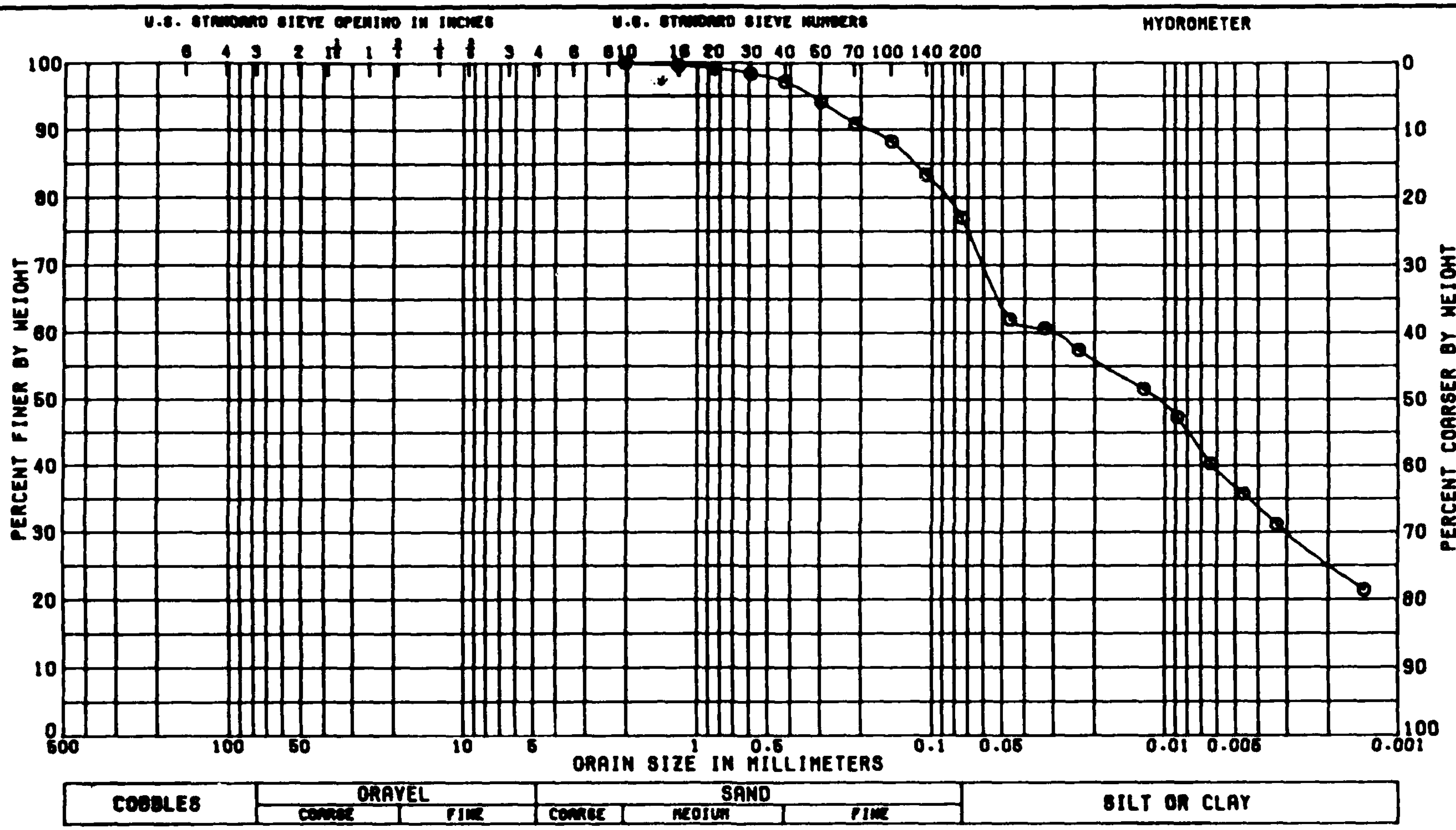
PROJECT SAVANNAH HARBOR

MIDDLE RIVER

BORING NO. 0 SAMPLE NO. 60

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E11



LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION

SANDY CLAY (CL), BROWN

GRADATION CURVE

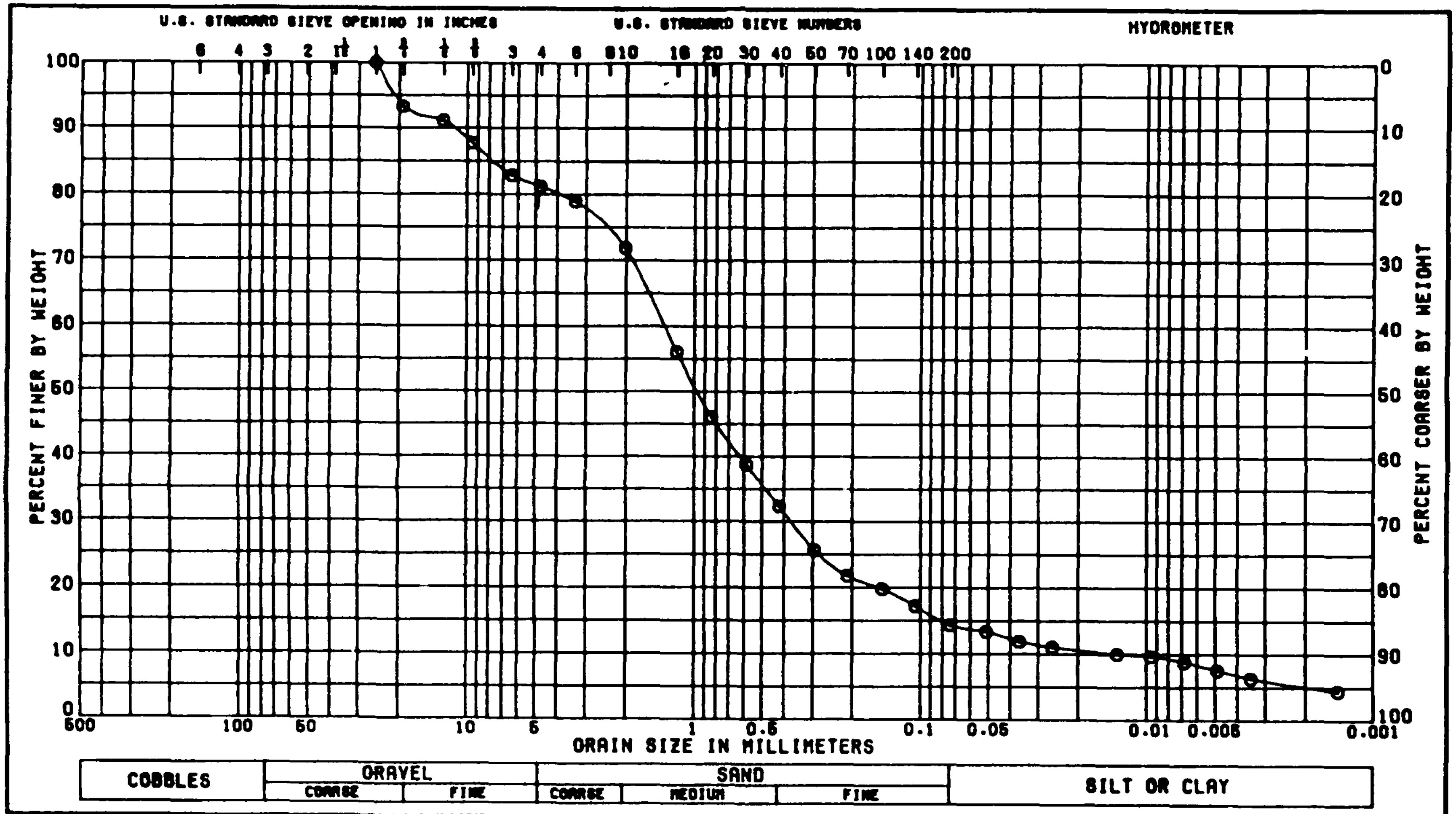
PROJECT SAVANNAH HARBOR

KINGS ISLAND TURNING BASIN

BORING NO. 0 SAMPLE NO. 61

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E12



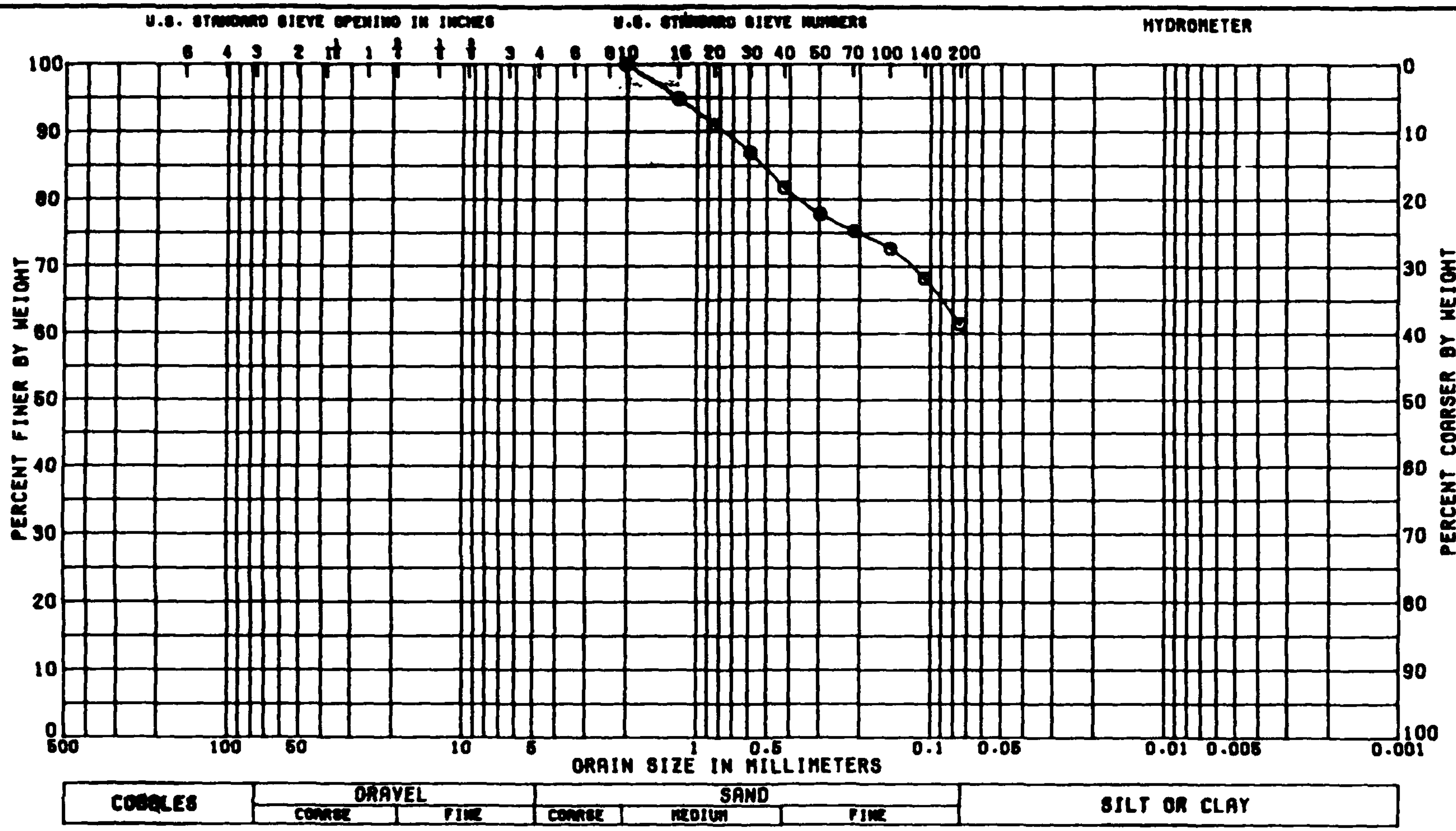
LL	PL	PI	GS 2.65	NAT W.%	ORG: Insuf.

CLASSIFICATION
GRAVELLY SAND
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT SAVANNAH HARBOR
KINGS ISLAND CHANNEL
BORING NO. 0 SAMPLE NO. 62
DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E13



LL	PL	PI	GS	NAT W.%	

CLASSIFICATION

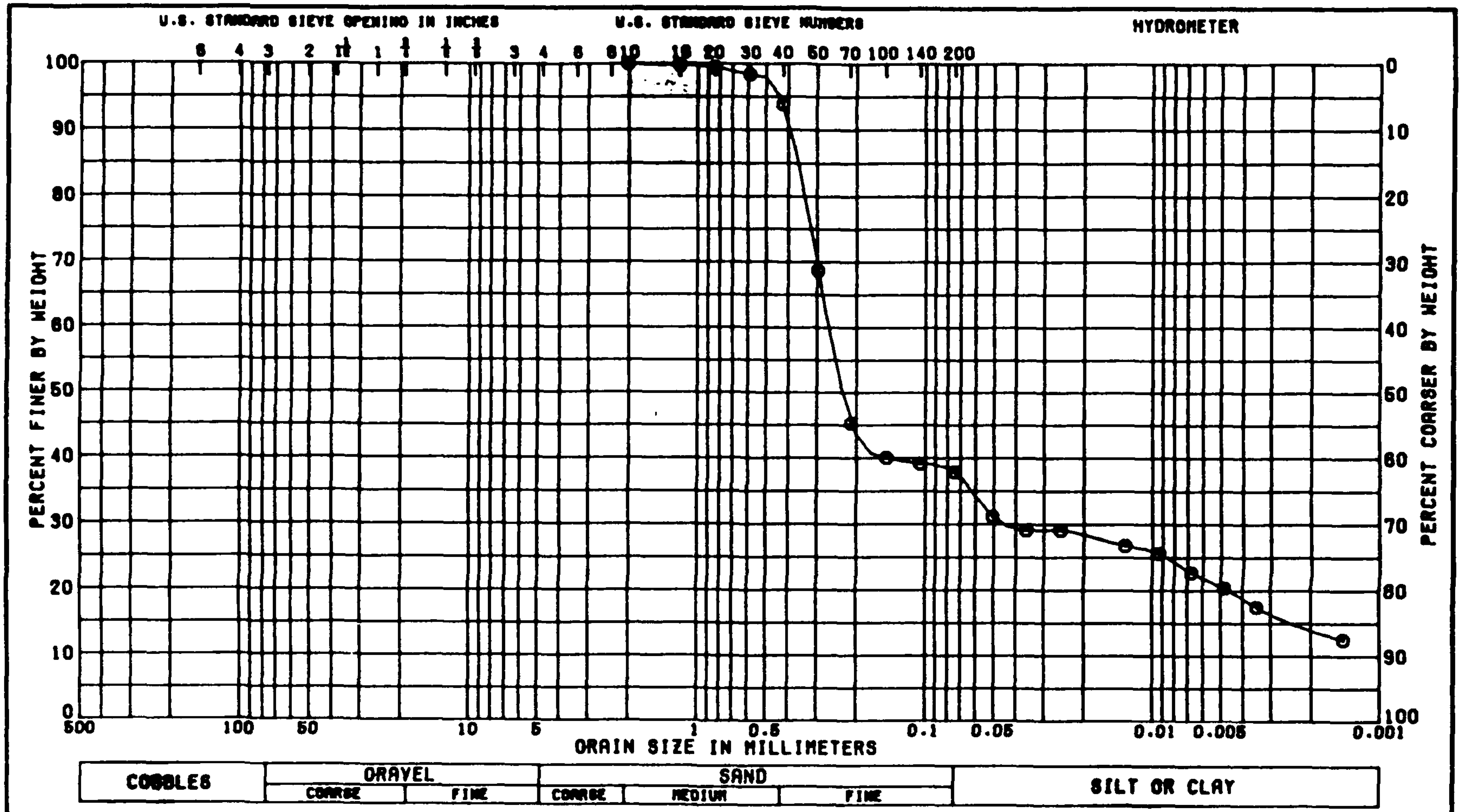
GRADATION CURVE

PROJECT SAVANNAH HARBOR
KINGS ISLAND CHANNEL

BORING NO. 0 SAMPLE NO. 63

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E14



LL	PL	PI	GS 2.65 EST	NAT W.%	

CLASSIFICATION

SILTY SAND (SM), GRAY

GRADATION CURVE

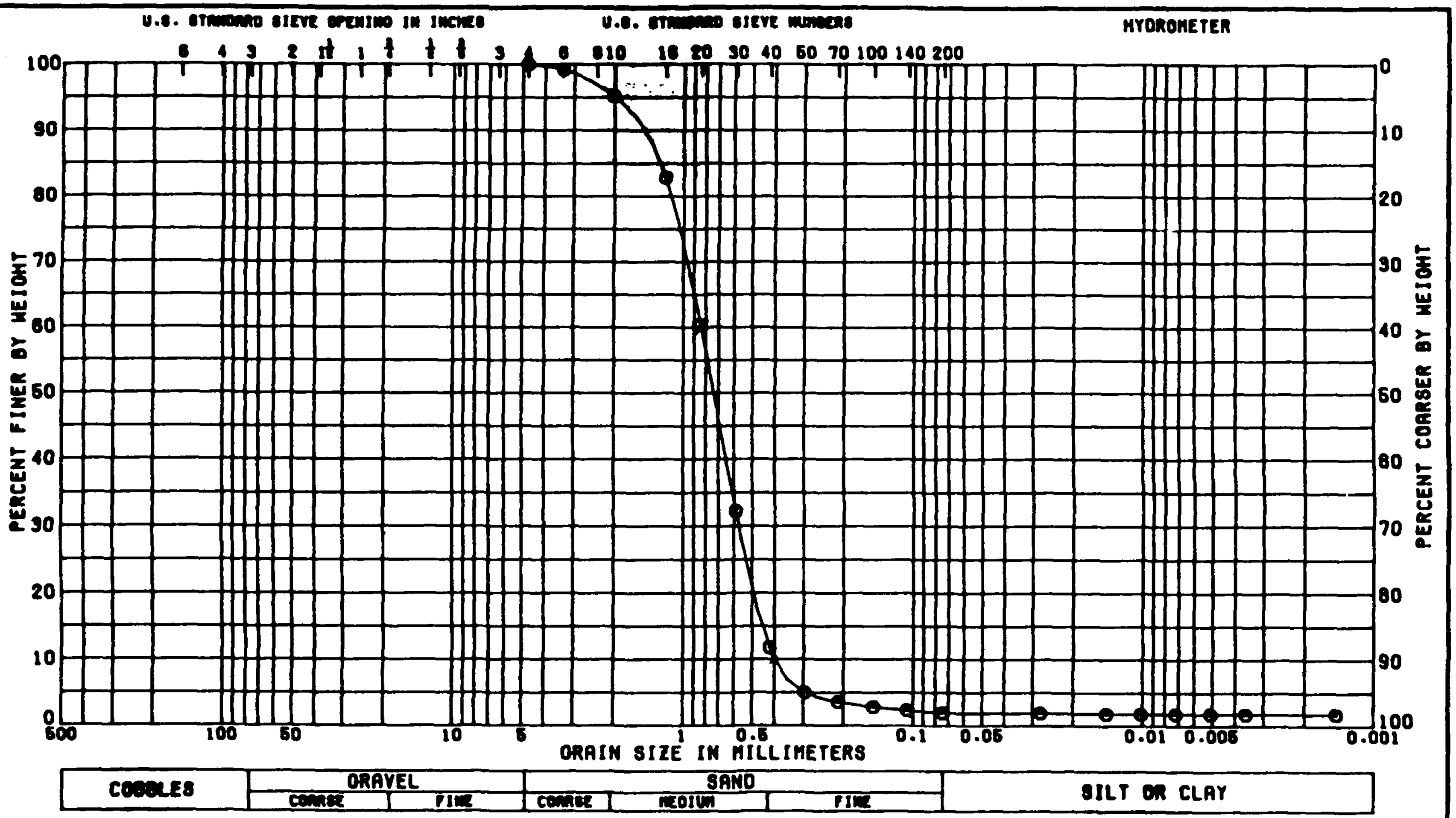
PROJECT SAVANNAH HARBOR

MARSH ISLAND TURNING BASIN

BORING NO. 0 SAMPLE NO. 64

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E15

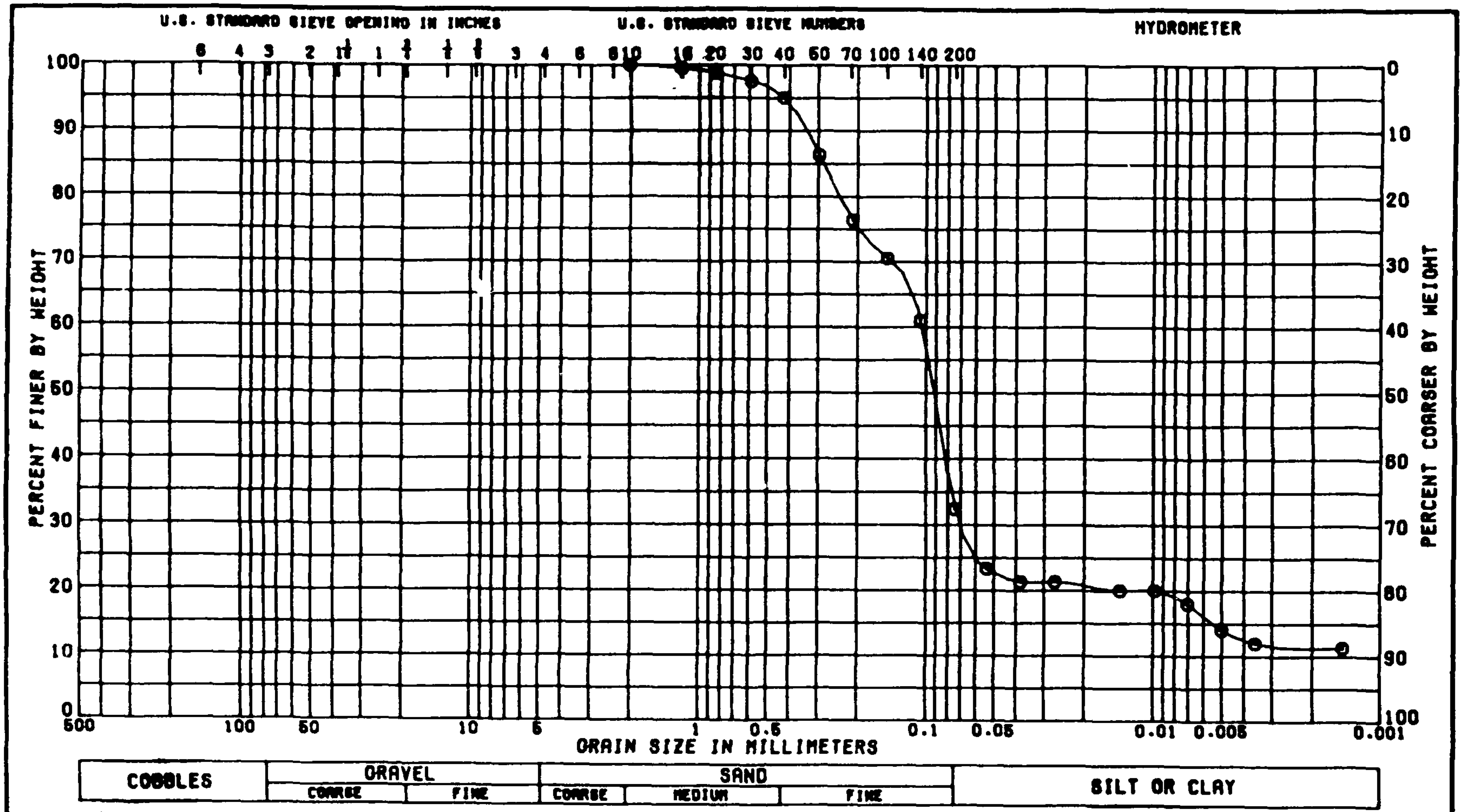


LL	PL	PI	GS 2.66	NAT W.%	ORG: .2%

CLASSIFICATION
SAND (SP), BROWN

PROJECT SAVANNAH HARBOR
KINGS ISLAND CHANNEL
BORING NO. 0 SAMPLE NO. 65
DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE



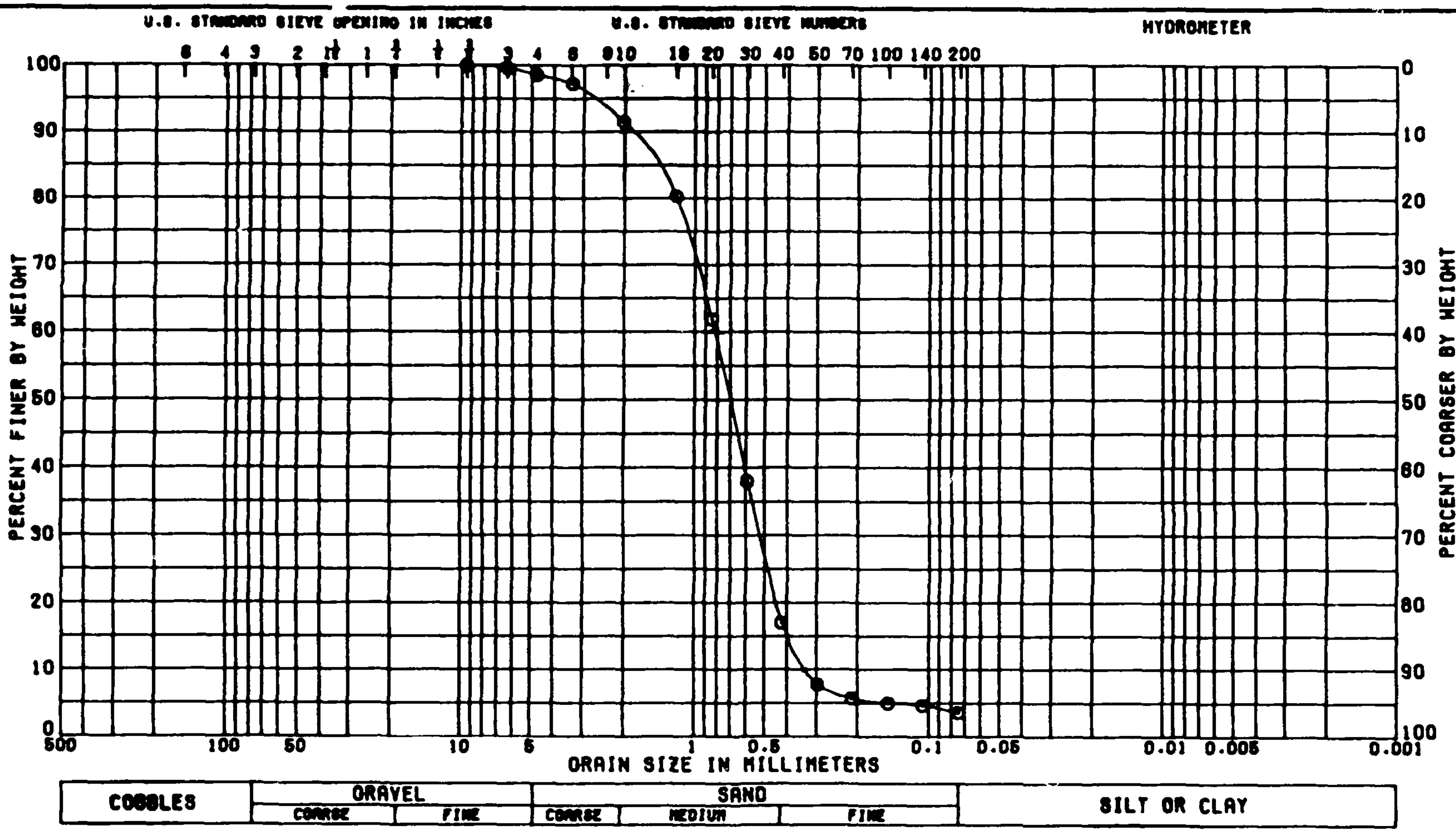
LL	PL	PI	GS 2.65 EST	NAT W.%	

CLASSIFICATION
SAND

GRADATION CURVE

PROJECT SAVANNAH HARBOR
MARSH ISLAND CHANNEL
BORING NO. 0 SAMPLE NO. 66
DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E17



LL	PL	PI	GS	NAT W.%	

CLASSIFICATION

SAND (SP), BROWN

GRADATION CURVE

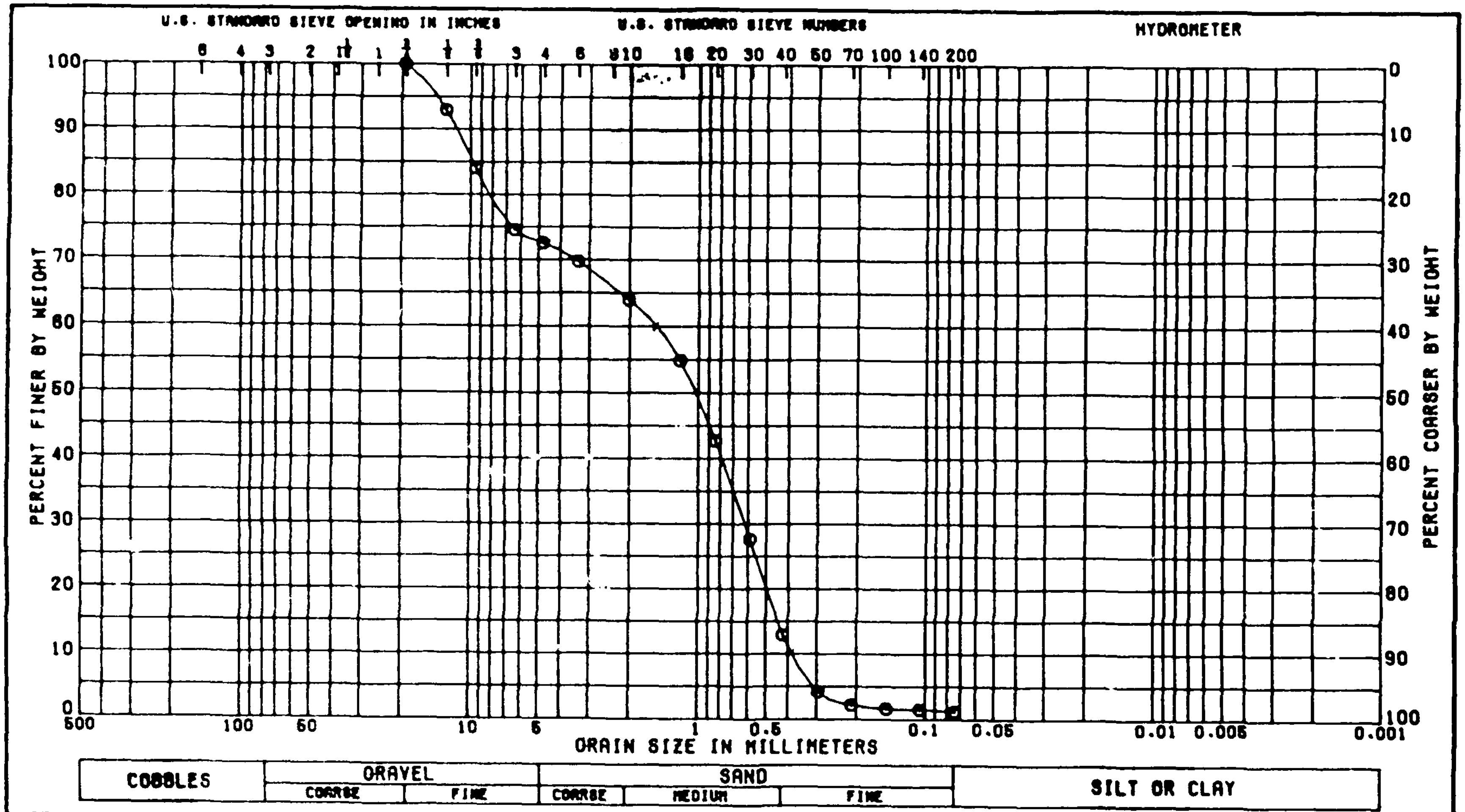
PROJECT SAVANNAH HARBOR

MARSH ISLAND CHANNEL

BORING NO. 0 SAMPLE NO. 67

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E18



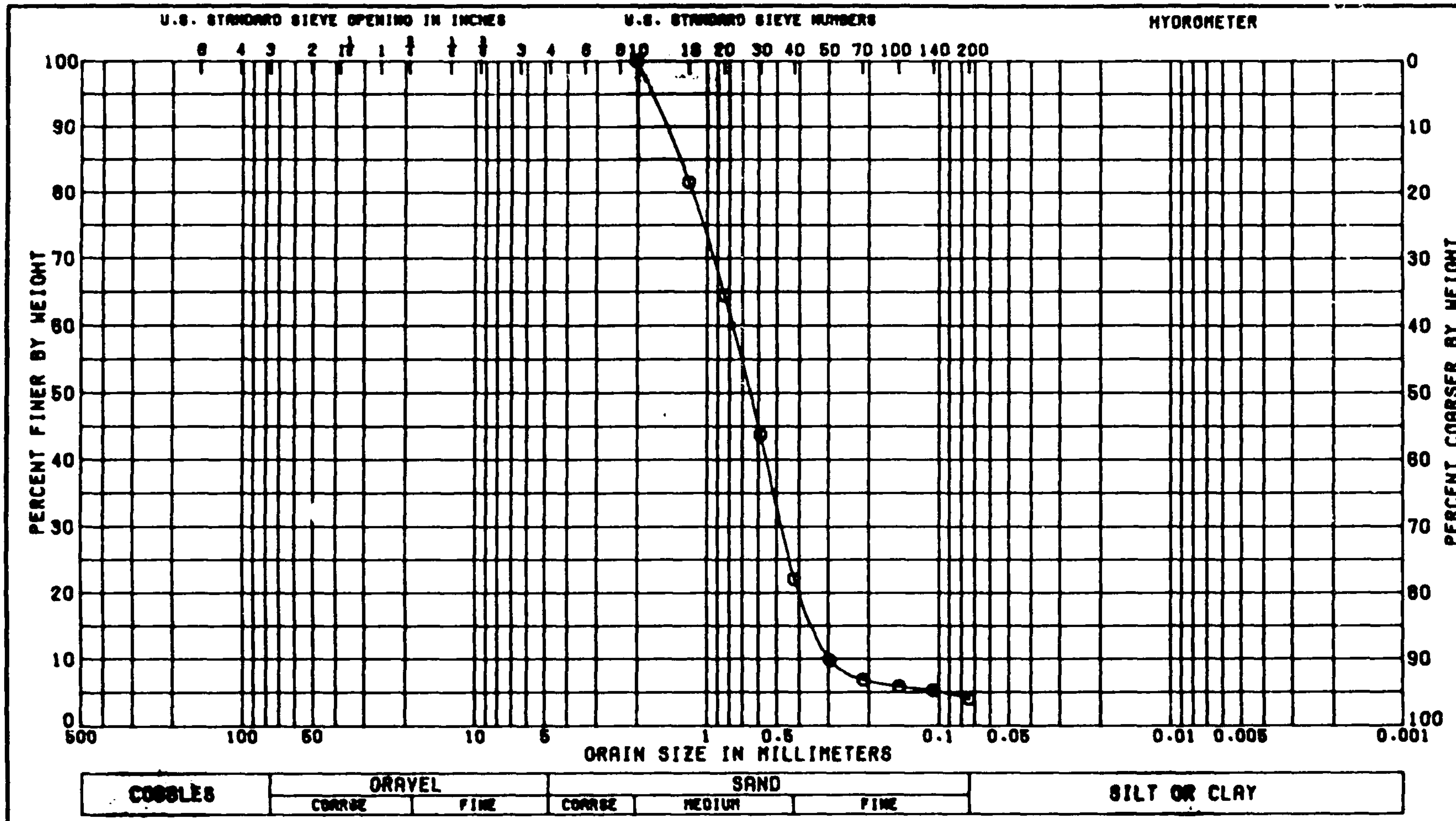
LL	PL	PI	GS	NAT W.%	

CLASSIFICATION

SAND (SP), BROWN; GRAVELLY
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT SAVANNAH HARBOR
MARSH ISLAND CHANNEL
BORING NO. 0 SAMPLE NO. 68
DEPTH/ELEV 0 DATE 12 JUL 86



LL	PL	PI	GS 2.66	NAT W.%	ORG: .8%

CLASSIFICATION

SAND (SP), BROWN

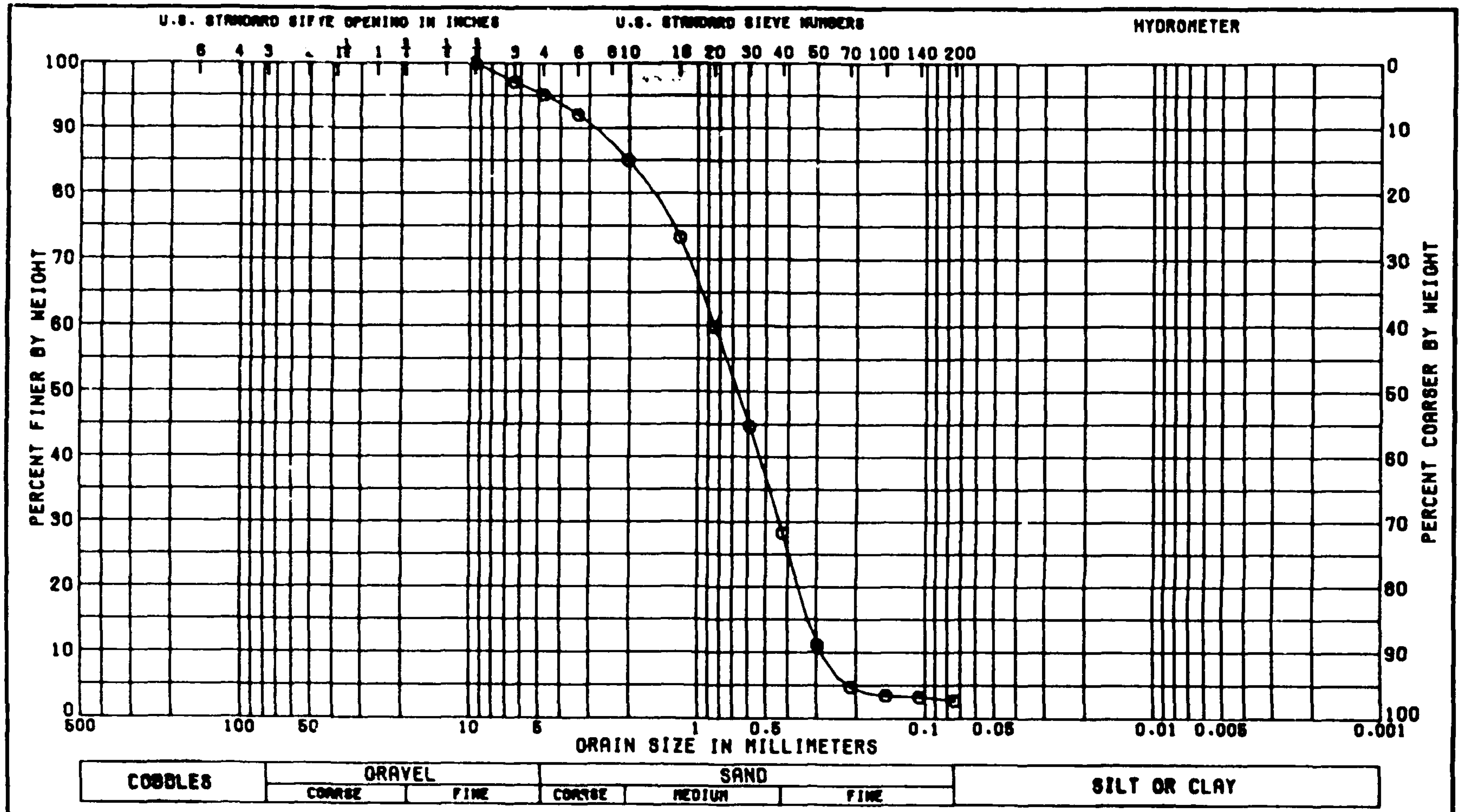
PROJECT SAVANNAH HARBOR
CITY FRONT CHANNEL

BORING NO. 0   SAMPLE NO. 69

DEPTH/ELEV 0   DATE 12 JUL 85

GRADATION CURVE

PLATE E20



LL	PL	PI	GS 2.66	NAT W.%	ORG: .4%

CLASSIFICATION

SAND (SP), BROWN: TRACE OF GRAVEL

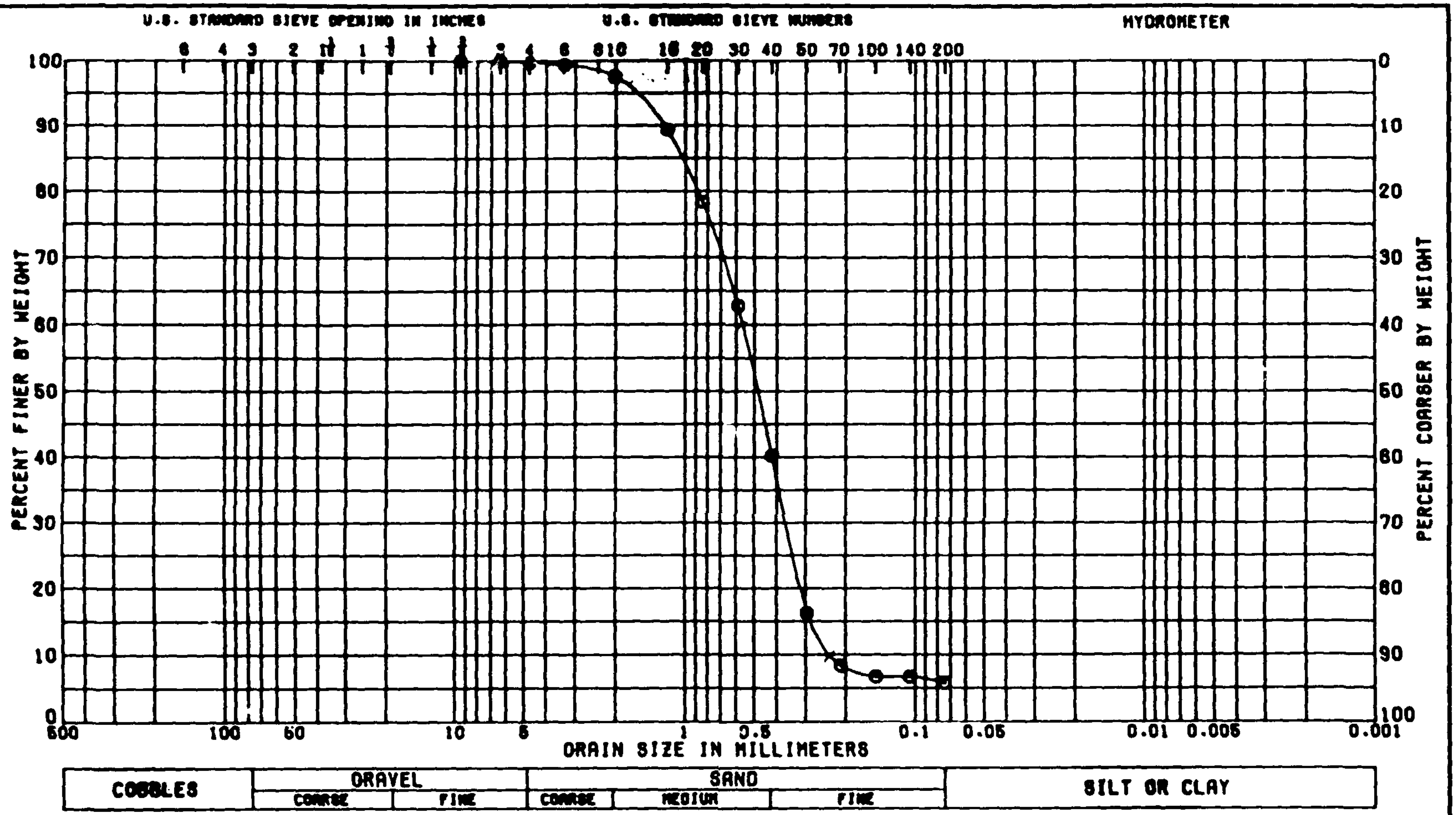
PROJECT SAVANNAH HARBOR

CITY FRONT CHANNEL

BORING NO. 0 SAMPLE NO. 70

DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE



LL	PL	PI	GS 2.65 EST	NAT W.%	

CLASSIFICATION

SILTY SAND (SP-SM), GRAY

GRADATION CURVE

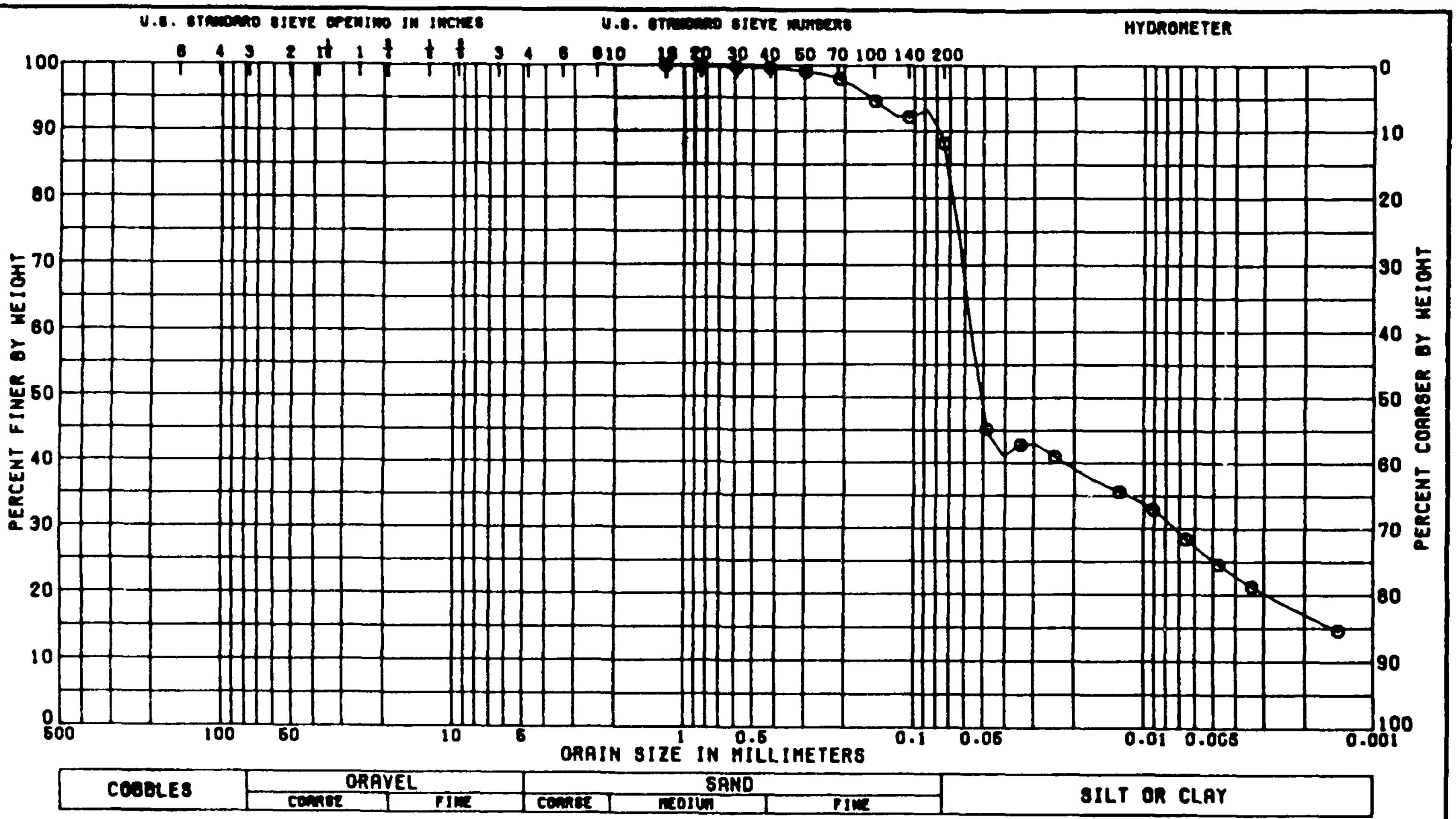
PROJECT SAVANNAH HARBOR

CITY FRONT CHANNEL

BORING NO. 0 SAMPLE NO. 71

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E22



LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION

SILT (ML), GRAY: WITH SAND

GRADATION CURVE

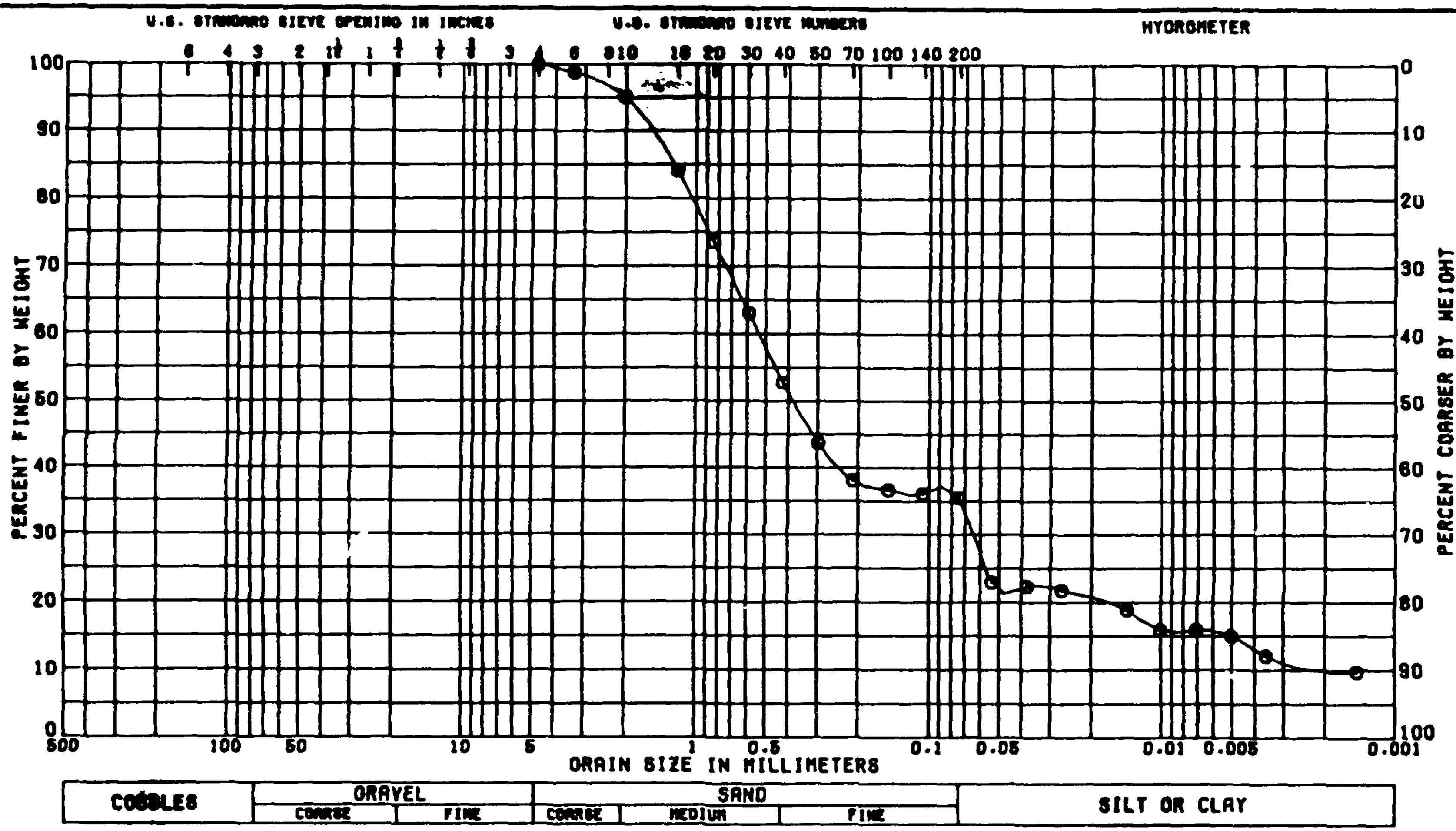
PROJECT SAVANNAH HARBOR

FIG ISLAND TURNING BASIN

BORING NO. 0 SAMPLE NO. 72

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E23



LL	PL	PI	GS 2.61	NAT W.%	ORG: 8.8%

CLASSIFICATION

CLAYEY SAND (SC), GRAY

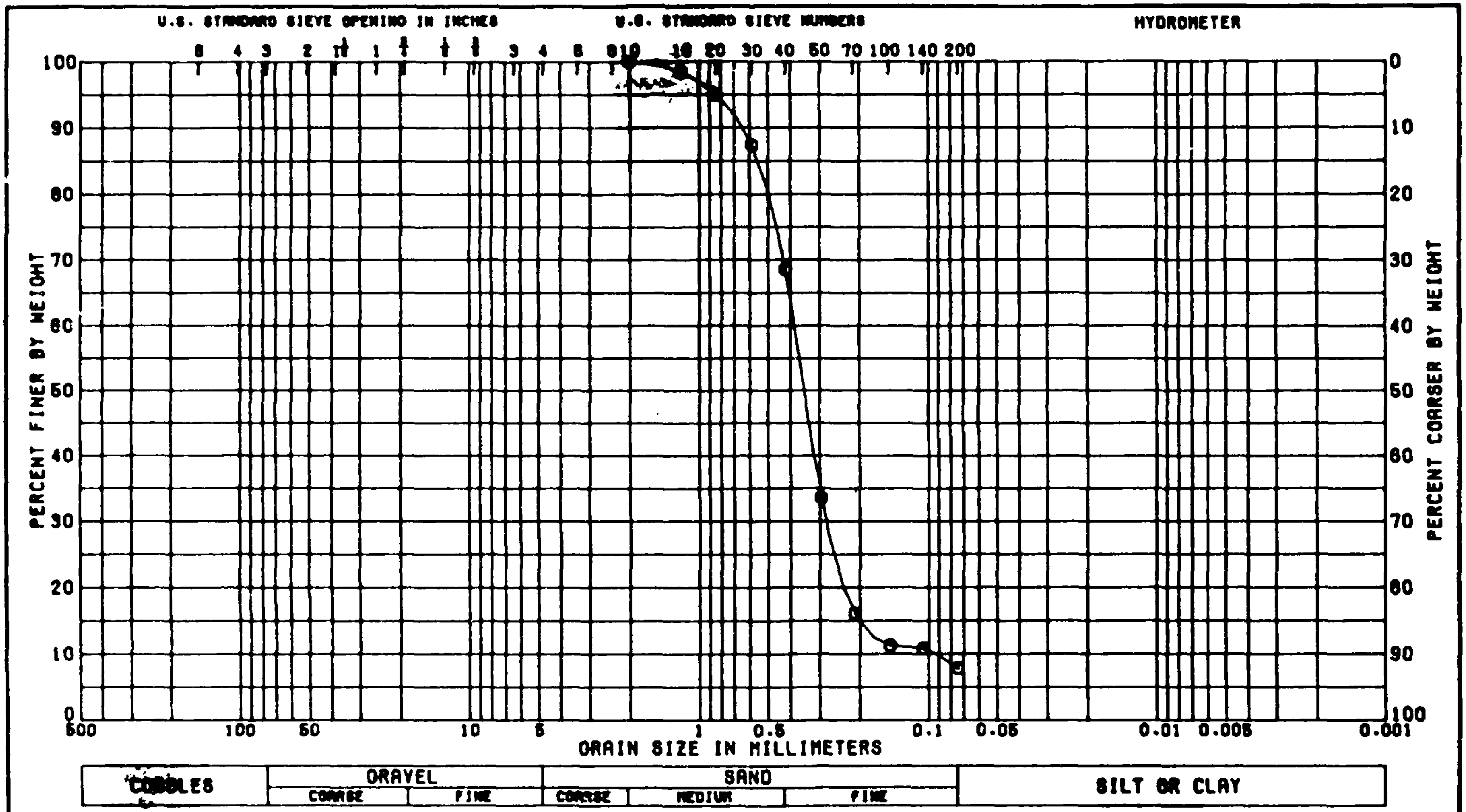
GRADATION CURVE

PROJECT SAVANNAH HARBOR

WRECKS CHANNEL

BORING NO. 0 SAMPLE NO. 73

DEPTH/ELEV 0 DATE 12 JUL 85



LL	PL	PI	GS 2.65 EST	NAT W.%	

CLASSIFICATION

SILTY SAND (SP-SM)

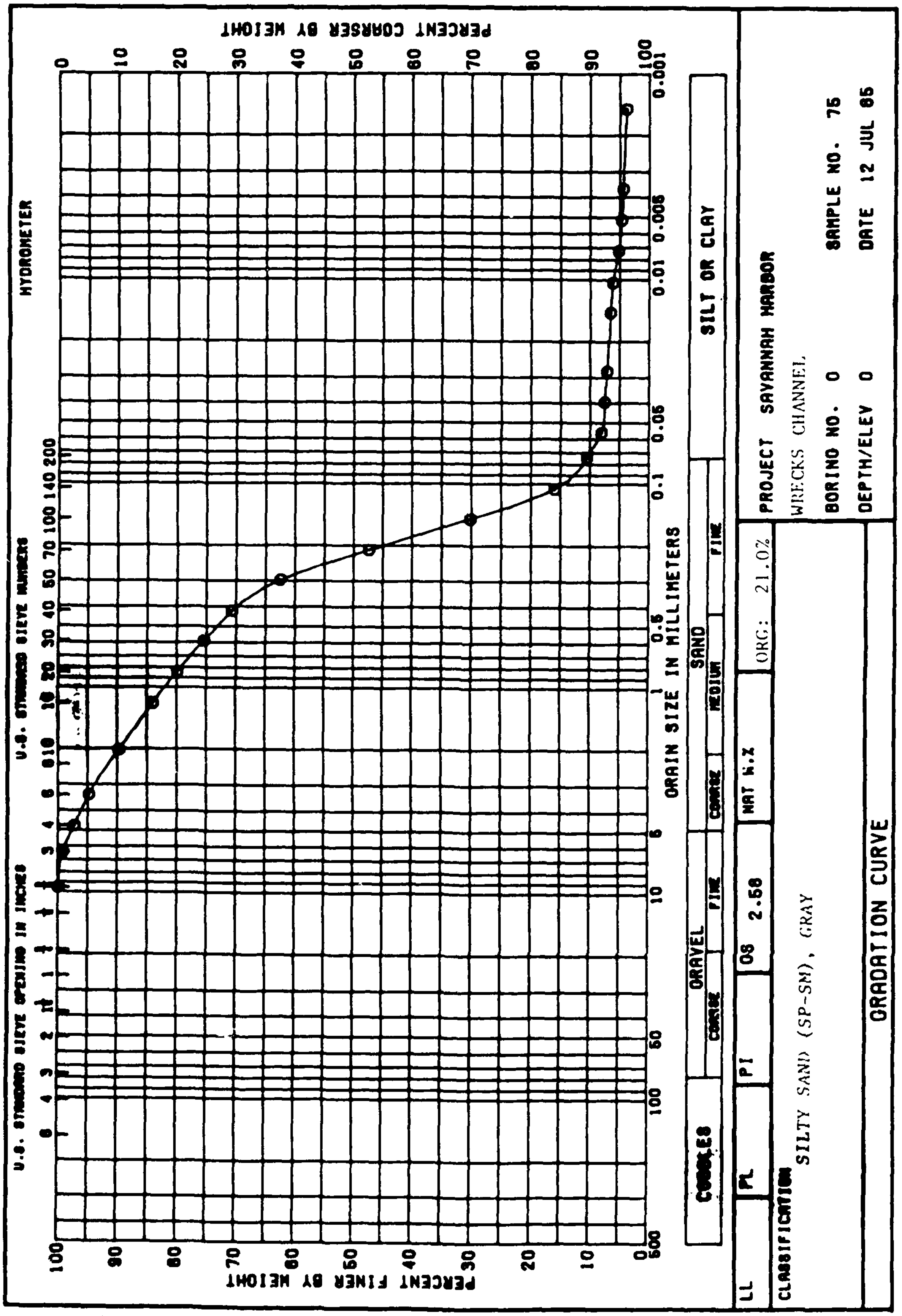
GRADATION CURVE

PROJECT SAVANNAH HARBOR

WRECKS CHANNEL

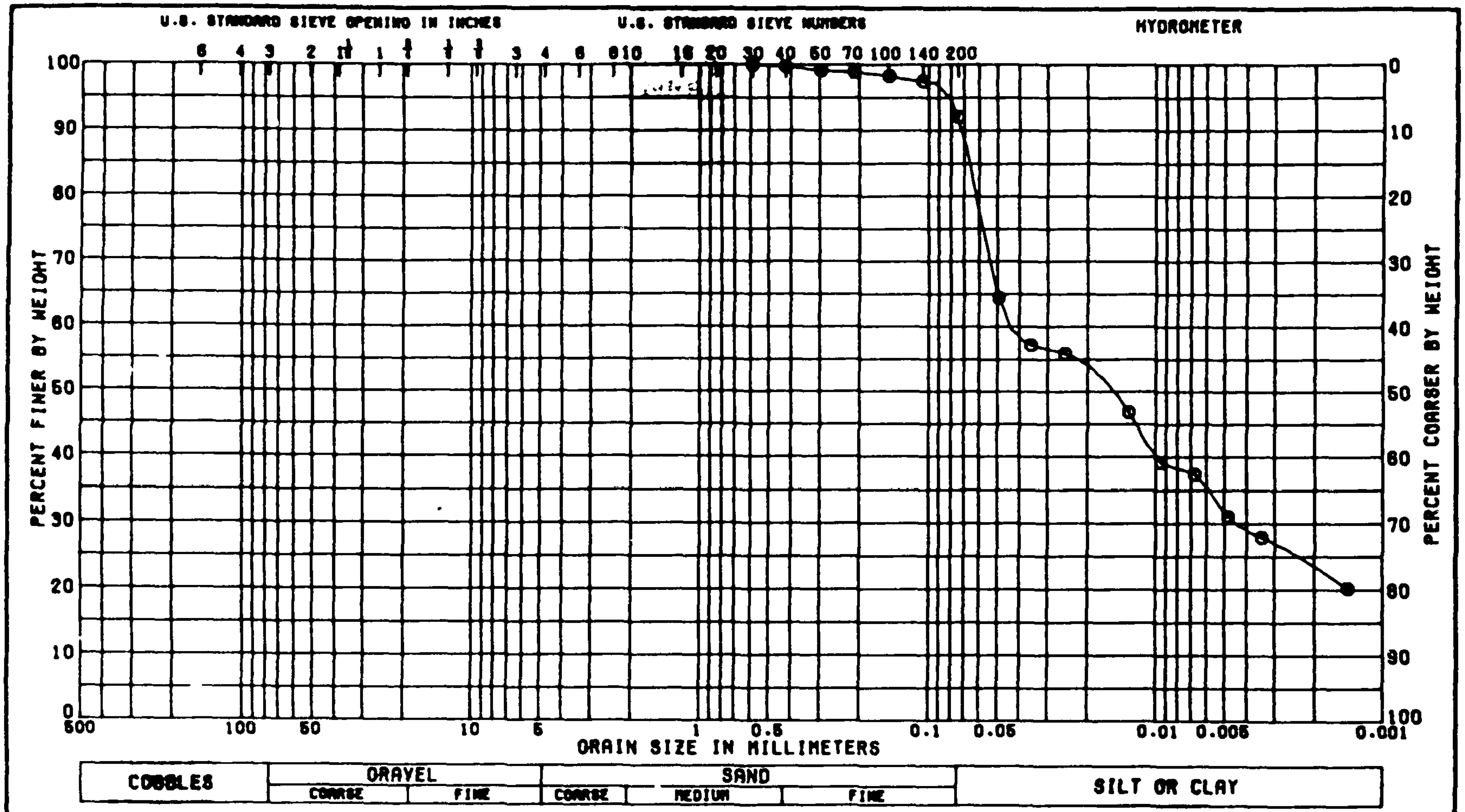
BORING NO. 0 SAMPLE NO. 74

DEPTH/ELEV 0 DATE 12 JUL 85



U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
LL
PL
PI
GS 2.58
NAT W.%
ORG: 21.0%
PROJECT SAVANNAH HARBOR
WRECKS CHANNEL
BORING NO. 0
SAMPLE NO. 75
DEPTH/ELEV 0
DATE 12 JUL 85
CLASSIFICATION
SILTY SAND (SP-SM), GRAY
GRADATION CURVE

PLATE E26

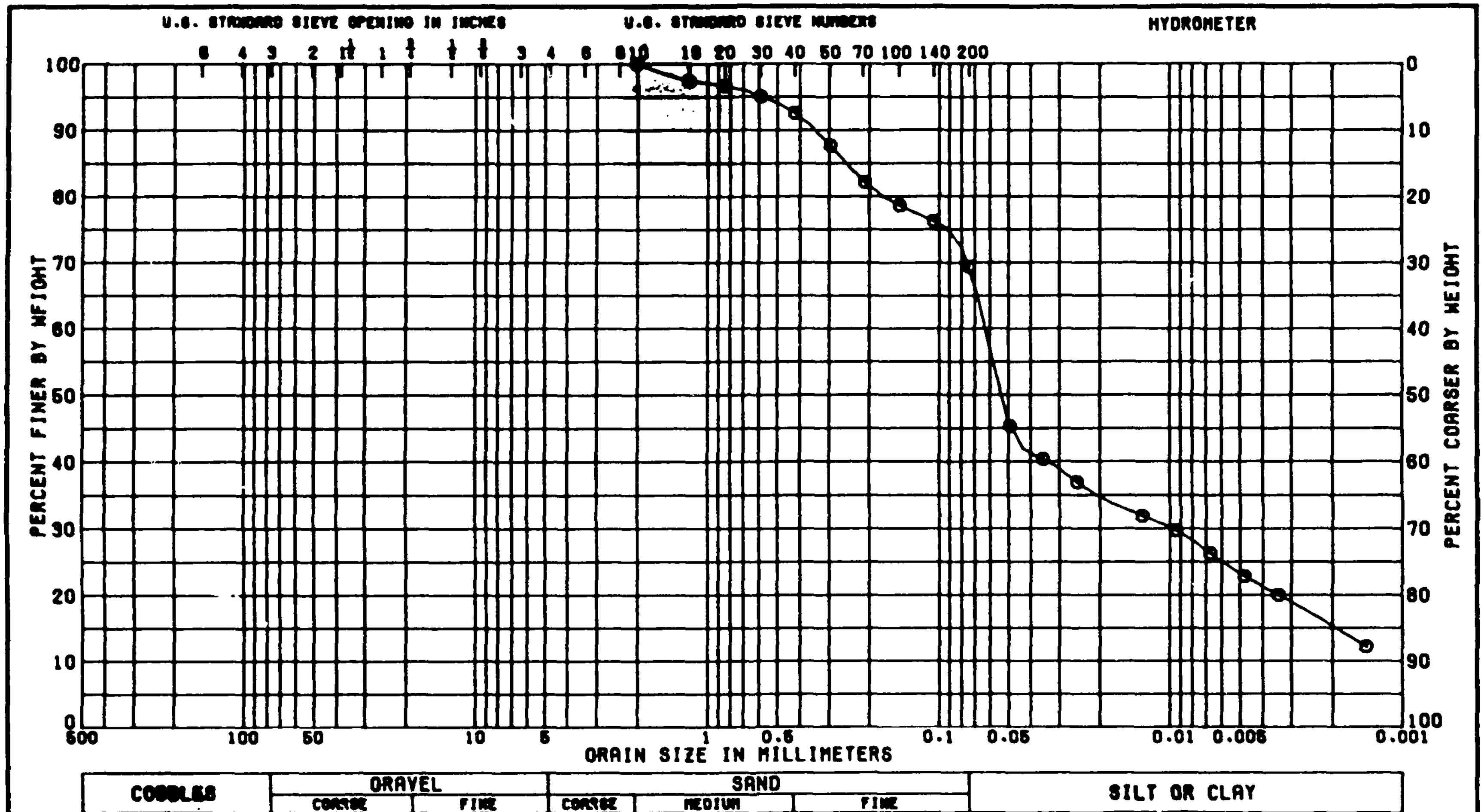


LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION
CLAY (CL), GRAY: WITH SAND

GRADATION CURVE

PROJECT SAVANNAH HARBOR
WRECKS CHANNEL
BORING NO. 0 SAMPLE NO. 76
DEPTH/ELEV 0 DATE 12 JUL 85

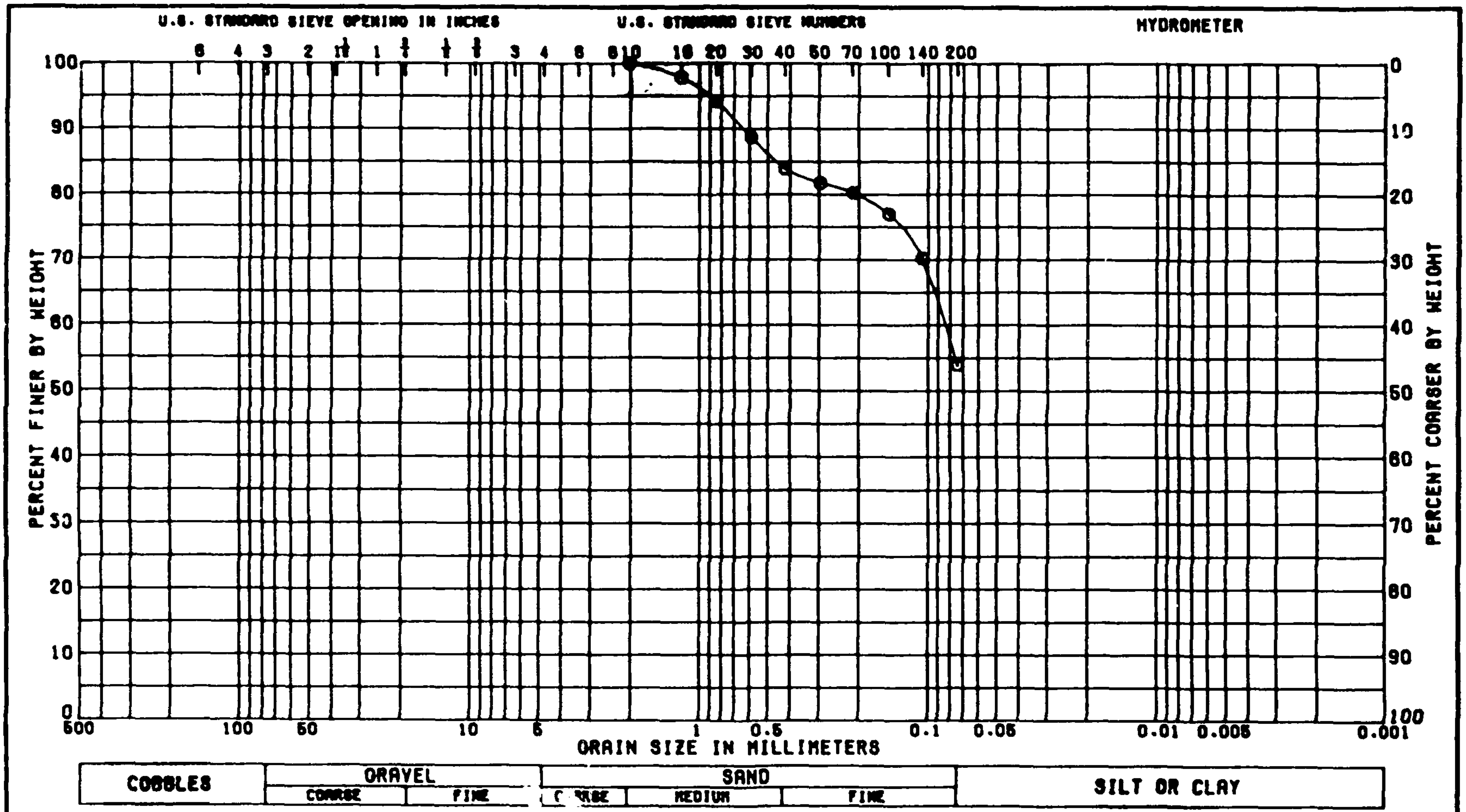


LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION
SANDY CLAY (CL), GRAY

GRADATION CURVE

PROJECT SAVANNAH HARBOR
OGLETHORPE RANGE
BORING NO. 0 SAMPLE NO. 77
DEPTH/ELEV 0 DATE 12 JUL 85



LL	PL	PI	GS 2.68 EST	NAT W.%	

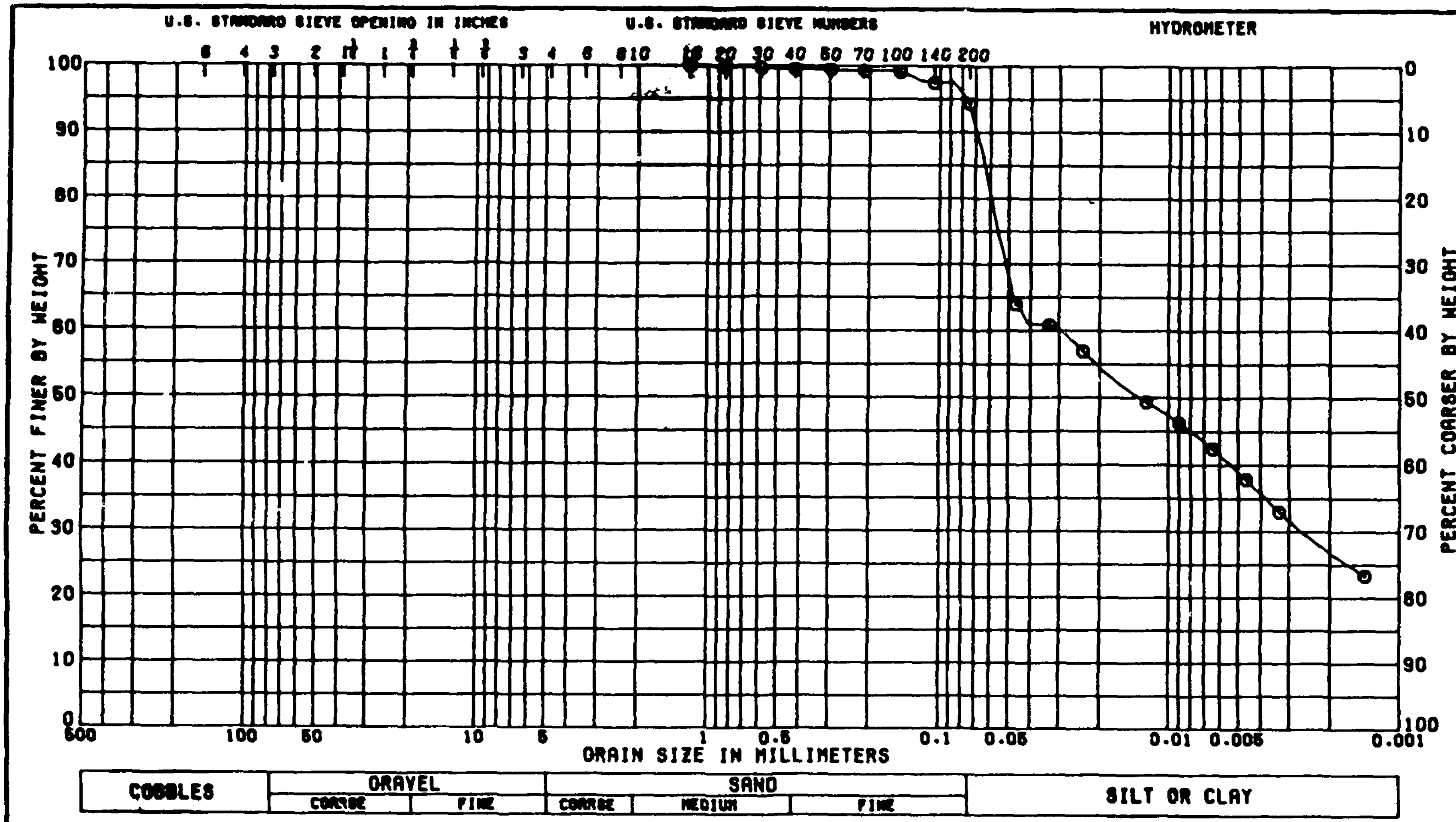
CLASSIFICATION
SANDY CLAY (CL), GRAY

GRADATION CURVE

PROJECT SAVANNAH HARBOR
OGLETHORPE RANGE

BORING NO. 0 SAMPLE NO. 78

DEPTH/ELEV 0 DATE 12 JUL 85



LL	PL	PI	GS 2.60	NAT W.%	ORG: 9.9%

CLASSIFICATION

CLAY (CL), GRAY: WITH SAND

GRADATION CURVE

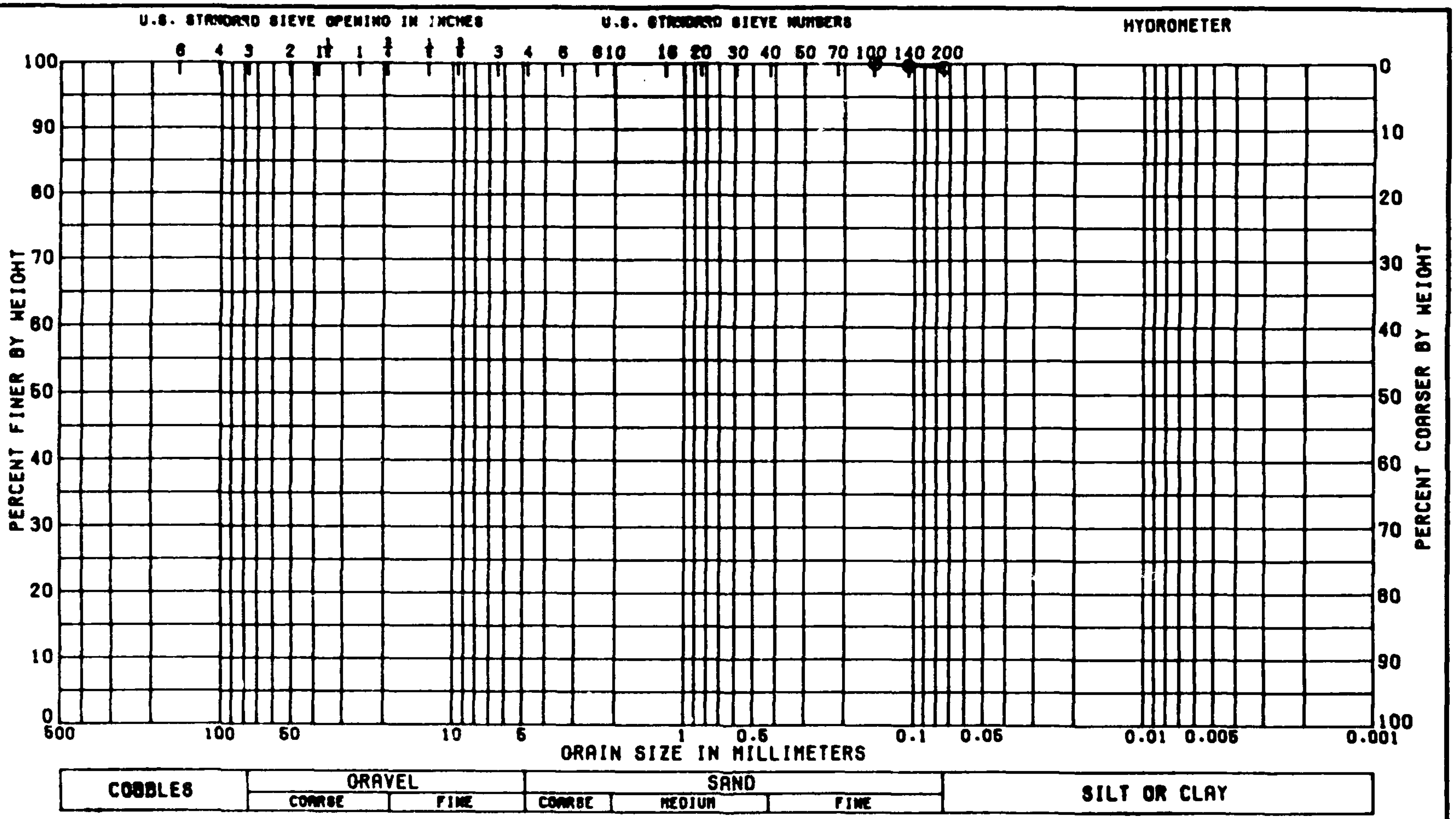
PROJECT SAVANNAH HARBOR

SEDIMENT TRAP, BACK RIVER

BORING NO. 0 SAMPLE NO. 79

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E30



LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION

CLAY (CL)

PROJECT SAVANNAH HARBOR

SEDIMENT TRAP, BACK RIVER

BORING NO. 0 SAMPLE NO. 80

DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE

PLATE E31

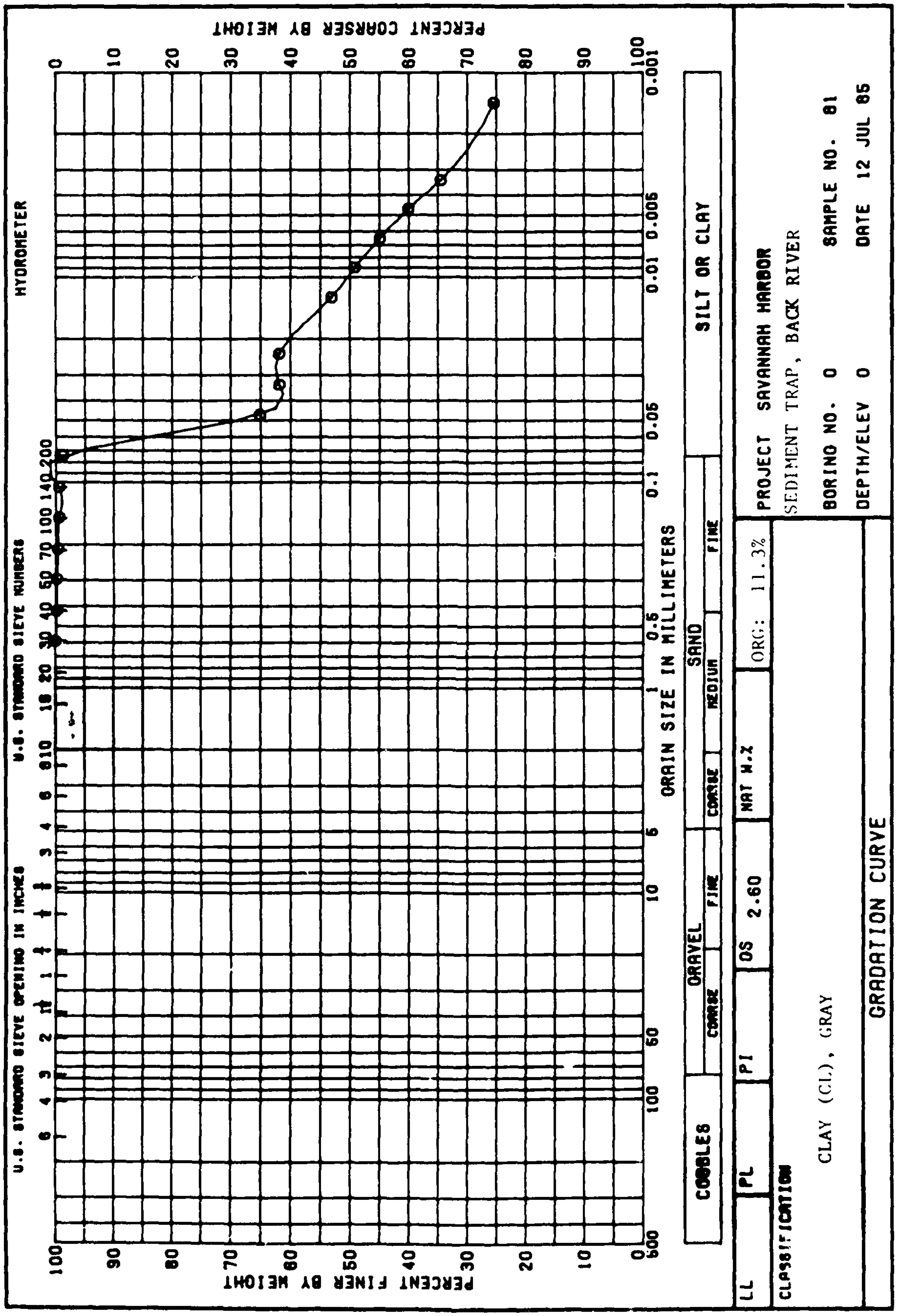
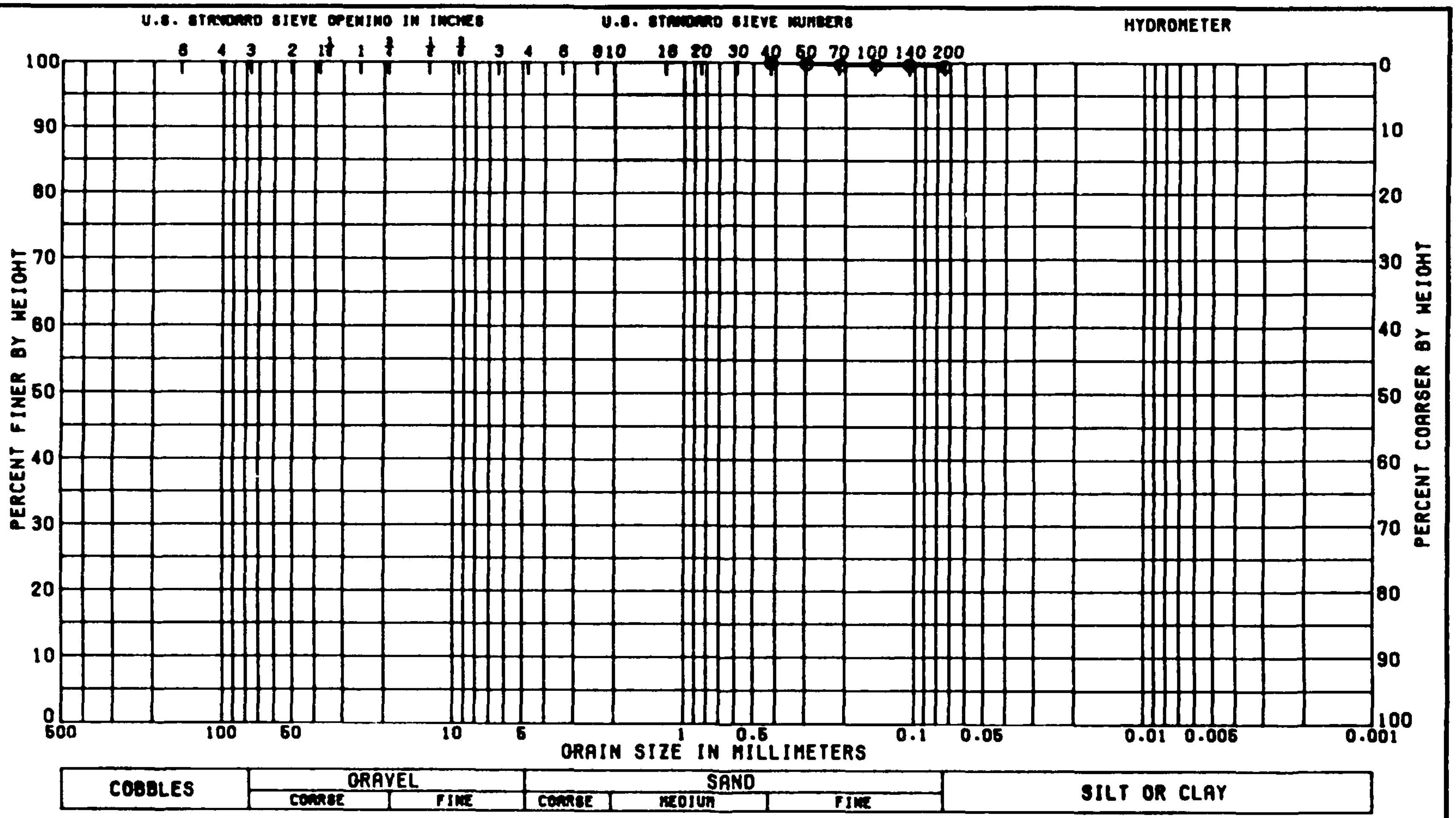

U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
LL
PL
PI
GS 2.60
NAT W.%
ORG: 11.3%
CLASSIFICATION
CLAY (CL), GRAY
PROJECT SAVANNAH HARBOR
SEDIMENT TRAP, BACK RIVER
BORING NO. 0
SAMPLE NO. 81
DEPTH/ELEV 0
DATE 12 JUL 85
GRADATION CURVE

PLATE E32



LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION

CLAY (CL), GRAY

GRADATION CURVE

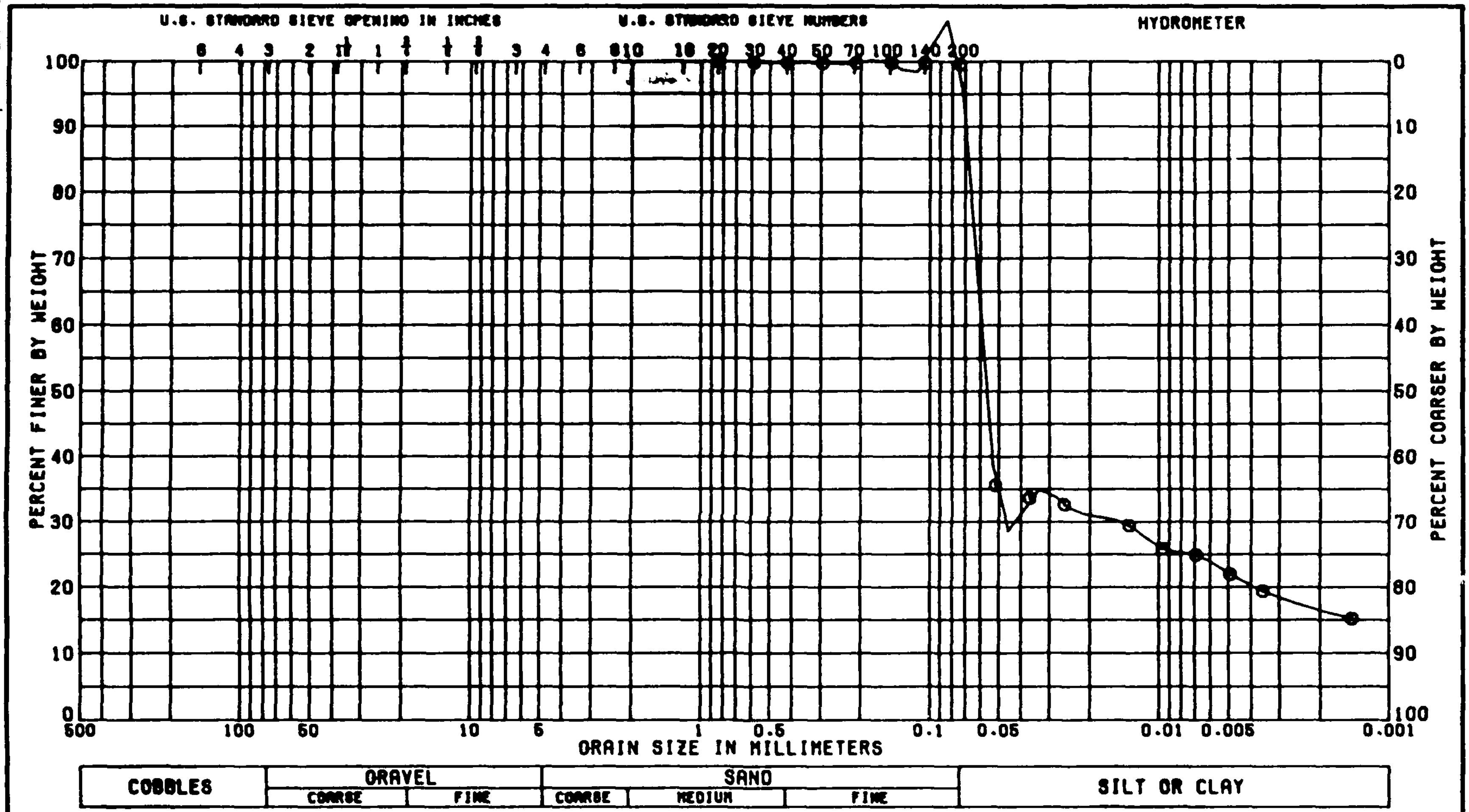
PROJECT SAVANNAH HARBOR

SEDIMENT TRAP, BACK RIVER

BORING NO. 0 SAMPLE NO. 82

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E33



LL	PL	PI	GS 2.58	NAT W.%	ORG: 12%

CLASSIFICATION

CLAY (CL), GRAY

PROJECT SAVANNAH HARBOR

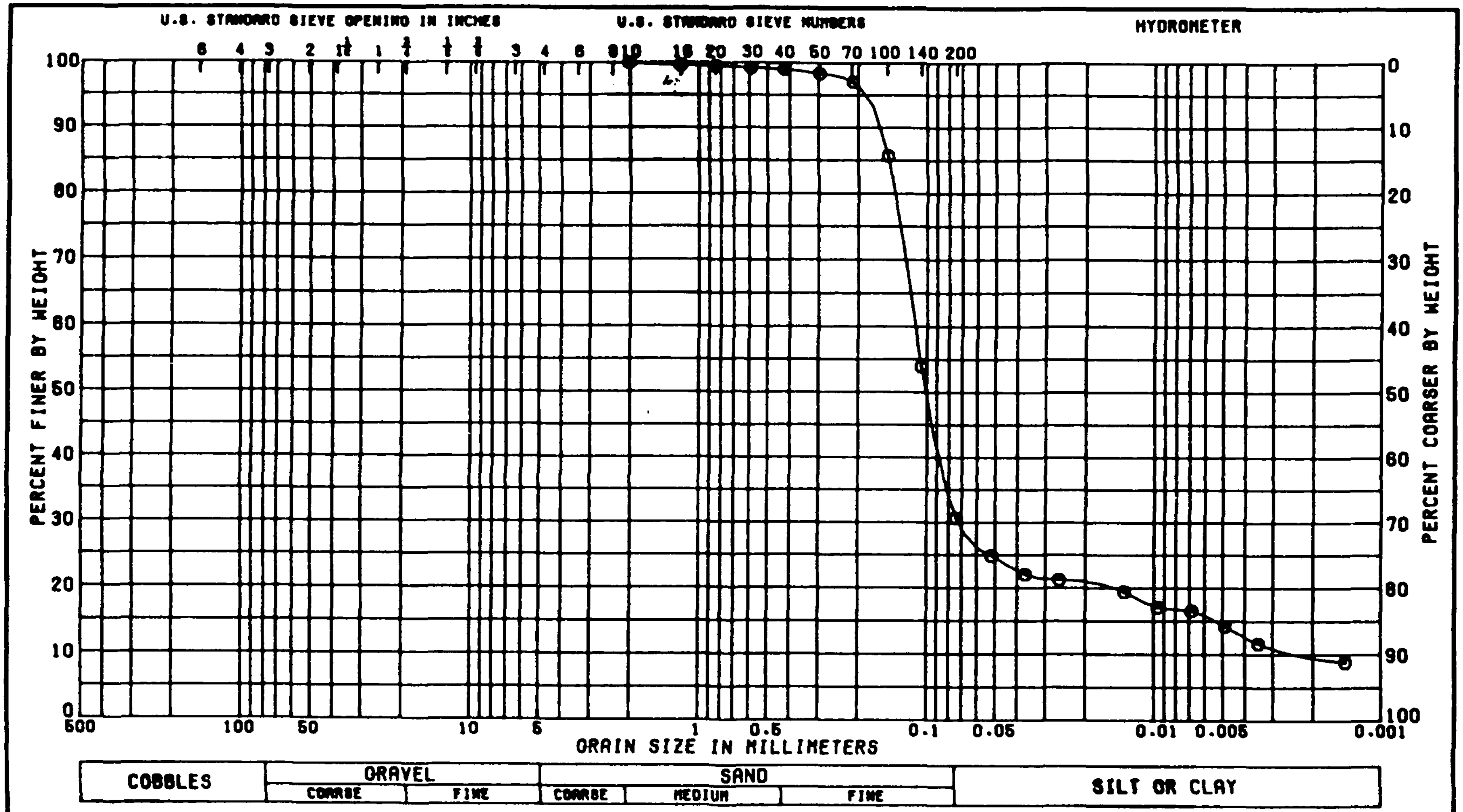
SEDIMENT TRAP, BACK RIVER

BORING NO. 0 SAMPLE NO. 83

DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE

PLATE E34



LL	PL	PI	GS 2.68	NAT W.%	ORG: 3.3%

CLASSIFICATION

SAND

GRADATION CURVE

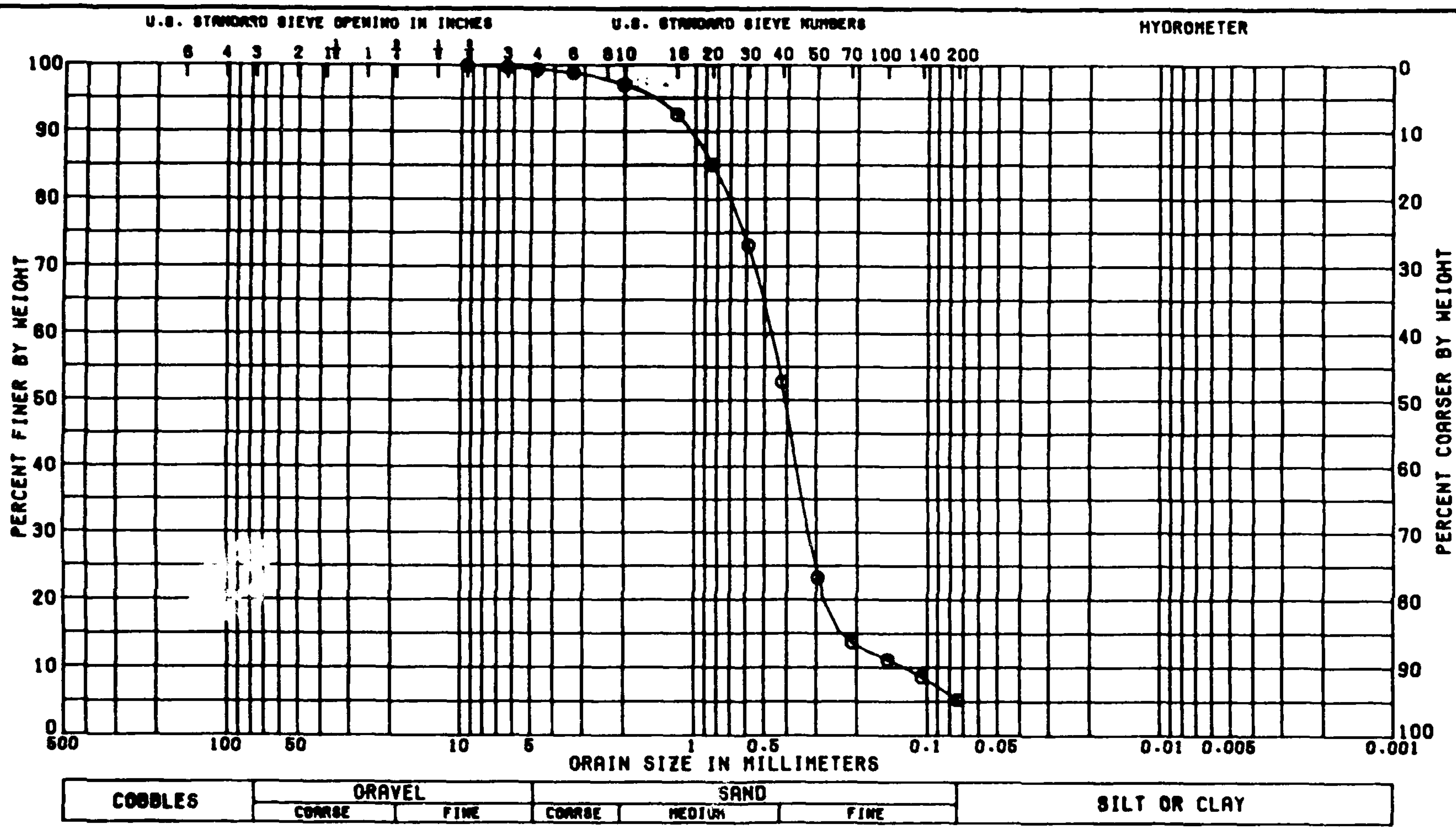
PROJECT SAVANNAH HARBOR
OGLETHORPE RANGE

BORING NO. 0 SAMPLE NO. 84

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E35

PLATE E36



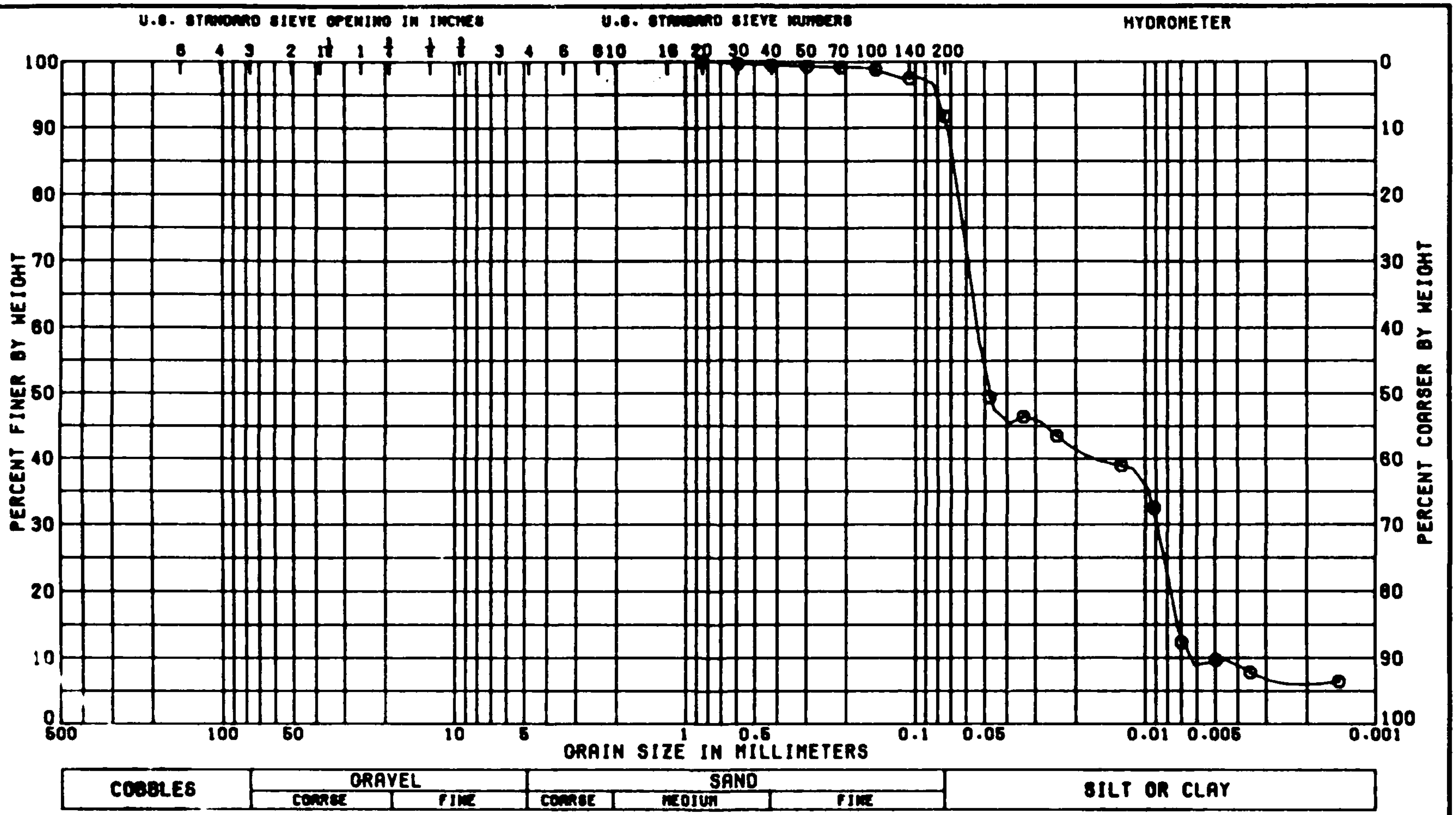
LL	PL	PI	GS 2.66	NAT W.%	ORG: 1.6%

CLASSIFICATION
CLAYEY SAND (SP-SC), GRAY

GRADATION CURVE

PROJECT SAVANNAH HARBOR
OGLETHORPE RANGE

BORING NO. 0 SAMPLE NO. 85
DEPTH/ELEV 0 DATE 12 JUL 85

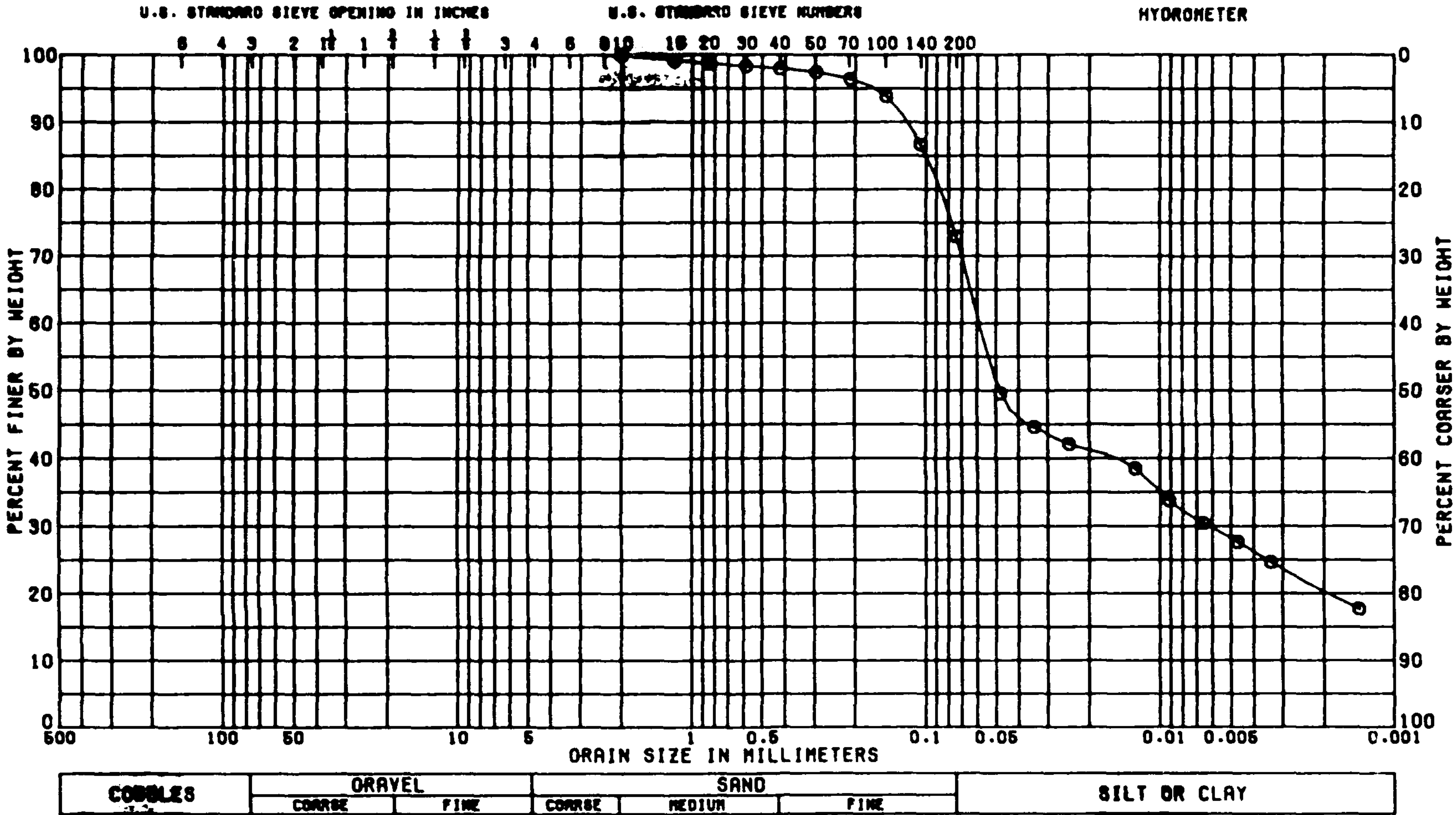


LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION
SILT (ML), BROWN: WITH SAND

PROJECT SAVANNAH HARBOR
FT. JACKSON RANGE
BORING NO. 0 SAMPLE NO. 86
DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE



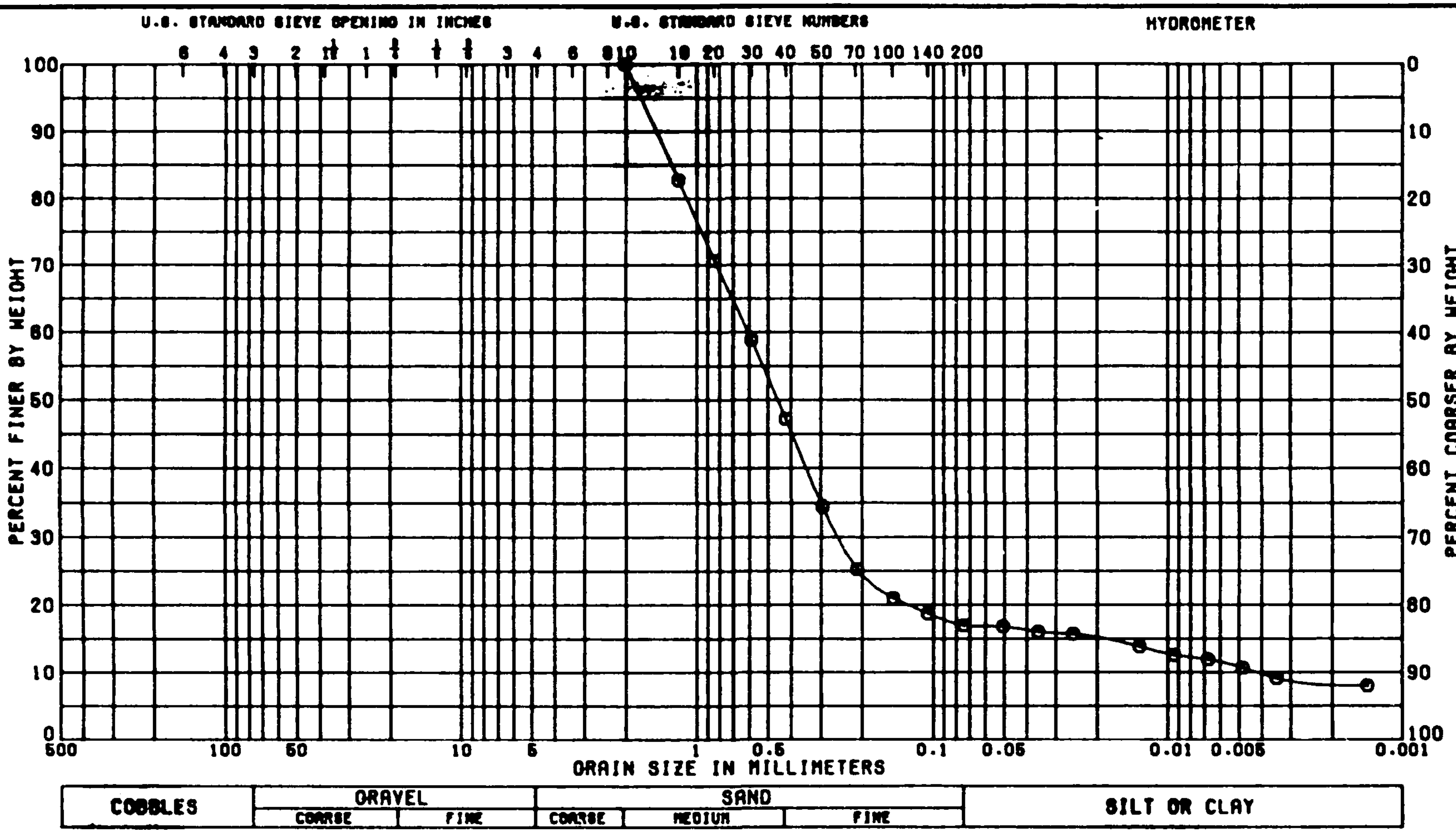
LL	PL	PI	GS 2.62	NAT W.%	ORG: 8.2%

CLASSIFICATION
SANDY CLAY (CL), GRAY

GRADATION CURVE

PROJECT SAVANNAH HARBOR
FT. JACKSON RANGE
BORING NO. 0 SAMPLE NO. 87
DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E38



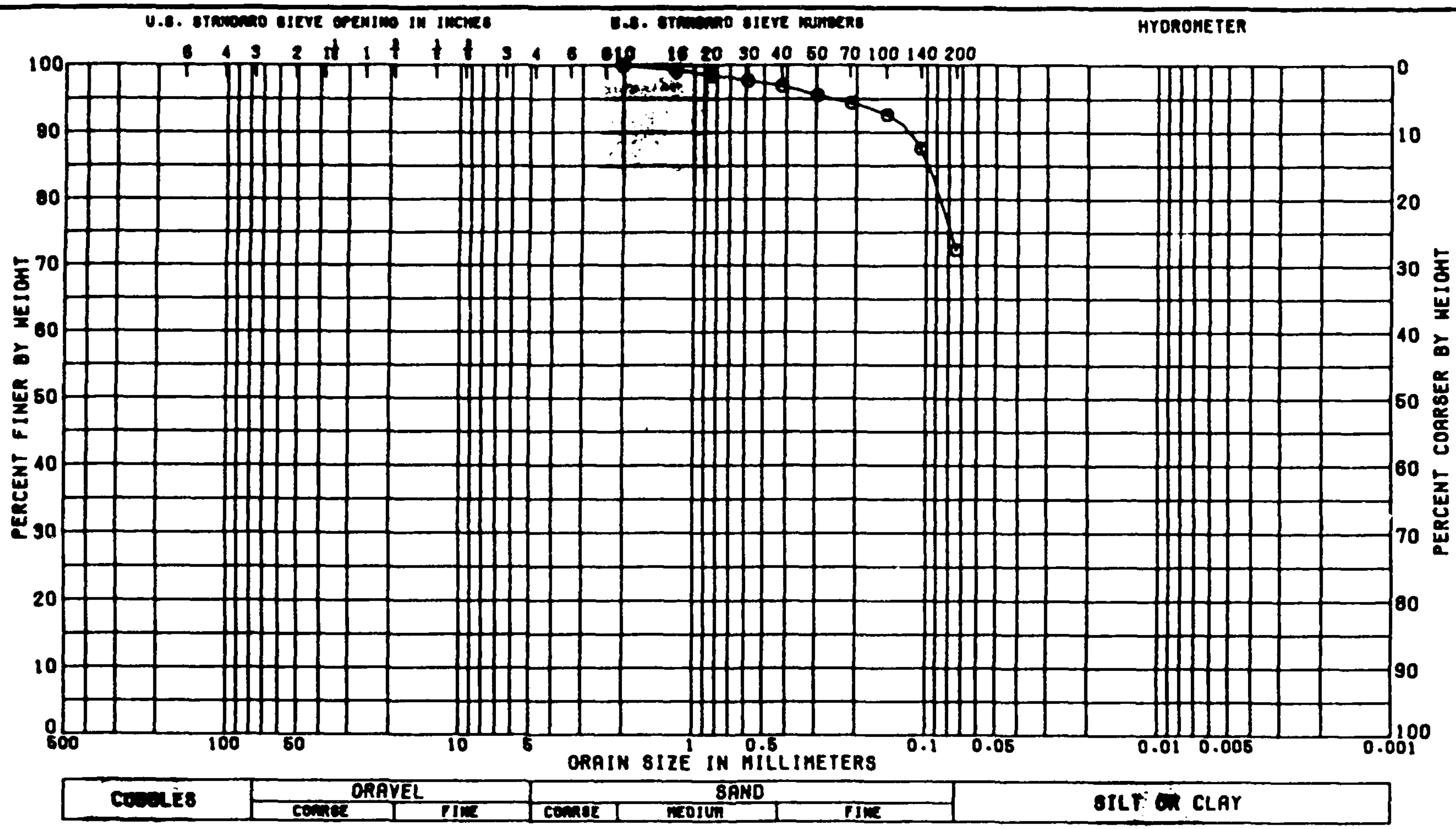
LL	PL	PI	GS 2.66	NAT W.%	ORG: 2.6%

CLASSIFICATION
SILTY SAND (SM), GRAY

PROJECT SAVANNAH HARBOR
THE BIGHT CHANNEL

BORING NO. 0 SAMPLE NO. 68
DEPTH/ELEV 0 DATE 12 JUL 85

GRADATION CURVE



LL	PL	PI	GS 2.68 EST	NAT W.%	

CLASSIFICATION

SANDY CLAY

GRADATION CURVE

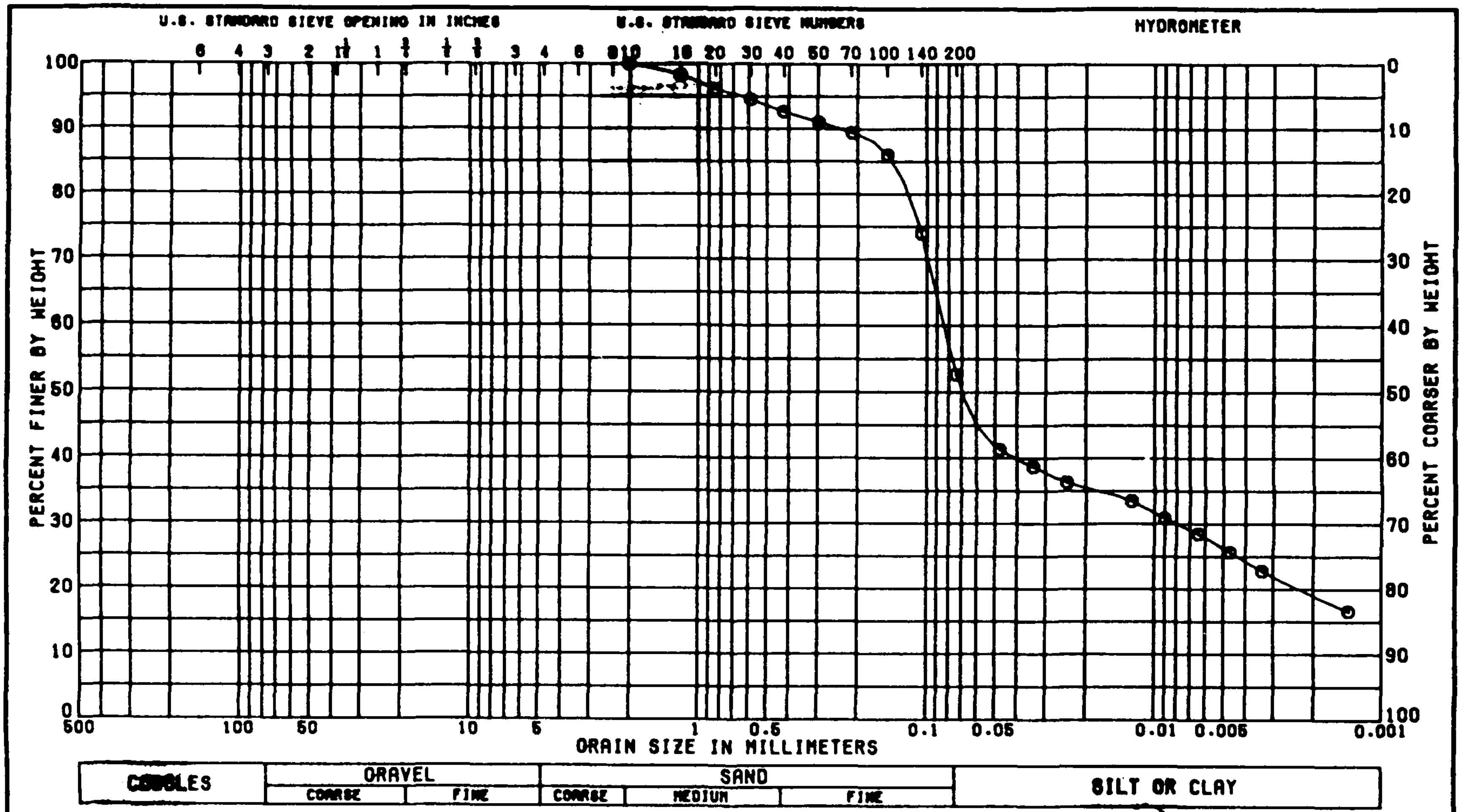
PROJECT SAVANNAH HARBOR

THE BIGHT CHANNEL

BORING NO. 0 SAMPLE NO. 89

DEPTH/ELEV 0 DATE 12 JUL 85

PLATE E40



LL	PL	PI	GS 2.64	NAT W.%	ORG: 6.8%

CLASSIFICATION
SANDY CLAY (CL), GRAY

GRADATION CURVE

PROJECT SAVANNAH HARBOR
THE BIGHT CHANNEL
BORING NO. 0 SAMPLE NO. 90
DEPTH/ELEV 0 DATE 12 JUL 85

APPENDIX F: SETTLING VELOCITY DATA

Niskin tube samples were collected at several ranges (Figure 1 in main text). Analyses of these samples provided an estimate of settling velocities of suspended material. Results are presented in Table F1. Variables are defined as follows:

Sal = Salinity

Conc = Initial suspended sediment concentration

Stl Height = Height of water in settling tube

Avg = Average settling velocity

Mn = Geometric mean settling velocity

Std Dev = Standard deviation

Skew = Skewness

Kort = Kortosis

Table F1

Settling Velocities

Range 1, Left Prism Line, 1200 hours

Sal=21.8 ppt   Conc= 64 mg/l   Stl Height= 0.85 m
Avg= 0.360 mm/sec   Mn= 0.173 mm/sec
Std Dev= 3.6   Skew.= 0.18   Kort.= 0.43

	Cumulative	Differential	
% >	Setl Vel,mm/sec	Setl Vel,mm/sec	Conc,mg/l
10	9.351E-01	1.9683-0.6561	9.8
20	5.006E-01	0.6561-0.2187	14.4
30	3.051E-01	0.2187-0.0729	20.2
40	1.999E-01	0.0729-0.0243	19.7
50	1.373E-01	0.0243-0.0081	0.0
60	9.761E-02	0.0081-0.0027	0.0
70	7.125E-02	0.0027-0.0009	0.0
80	5.312E-02	0.0009-0.0003	0.0
90	4.029E-02	Total classes	64.0

Range 2, Center of Channel, 1200 hours

Sal=12.0 ppt   Conc= 31 mg/l   Stl Height= 0.85 m
Avg= 0.505 mm/sec   Mn= 0.422 mm/sec
Std Dev= 7.7   Skew.= 0.15   Kort.= 0.39

	Cumulative	Differential	
% >	Setl Vel,mm/sec	Setl Vel,mm/sec	Conc,mg/l
10	5.659E+00	1.9683-0.6561	7.4
20	2.321E+00	0.6561-0.2187	5.8
30	1.094E+00	0.2187-0.0729	6.7
40	5.639E-01	0.0729-0.0243	6.9
50	3.097E-01	0.0243-0.0081	0.0
60	1.785E-01	0.0081-0.0027	0.0
70	1.069E-01	0.0027-0.0009	0.0
80	6.600E-02	0.0009-0.0003	0.0
90	4.184E-02	Total classes	26.7

Range 3, Center of Channel, 0715 hours

Sal=16.7 ppt   Conc= 35 mg/l   Stl Height= 0.86 m
Avg= 0.534 mm/sec   Mn= 0.306 mm/sec
Std Dev= 11.9   Skew.= 0.03   Kort.= 0.33

	Cumulative	Differential	
% >	Setl Vel,mm/sec	Setl Vel,mm/sec	Conc,mg/l
10	5.784E+00	1.9683-0.6561	10.3
20	2.668E+00	0.6561-0.2187	5.3
30	1.248E+00	0.2187-0.0729	5.4
40	5.922E-01	0.0729-0.0243	5.5
50	2.846E-01	0.0243-0.0081	5.3
60	1.384E-01	0.0081-0.0027	0.0
70	6.812E-02	0.0027-0.0009	0.0
80	3.390E-02	0.0009-0.0003	0.0
90	1.705E-02	Total classes	31.8

(Continued)

(Sheet 1 of 3)

Table F1 (Continued)

Range 5, Center of Channel, 1300 hours

Sal= 7.8 ppt Conc= 44 mg/l Stl Height= 0.85 m
Avg= 0.376 mm/sec Mn= 0.151 mm/sec
Std Dev= 6.6 Skew.= 0.19 Kort.= 0.46

	Cumulative	Differential	
% >	Setl Vel,mm/sec	Setl Vel,mm/sec	Conc,mg/l
10	1.837E+00	1.9683-0.6561	8.6
20	6.994E-01	0.6561-0.2187	7.0
30	3.356E-01	0.2187-0.0729	9.1
40	1.810E-01	0.0729-0.0243	11.1
50	1.052E-01	0.0243-0.0081	7.6
60	6.447E-02	0.0081-0.0027	0.0
70	4.110E-02	0.0027-0.0009	0.0
80	2.704E-02	0.0009-0.0003	0.0
90	1.825E-02	Total classes	43.5

Range 6, Center of Channel, 1330 hours

Sal= 7.1 ppt Conc= 39 mg/l Stl Height= 0.85 m
Avg= 0.270 mm/sec Mn= 0.157 mm/sec
Std Dev= 2.6 Skew.= 0.16 Kort.= 0.40

	Cumulative	Differential	
% >	Setl Vel,mm/sec	Setl Vel,mm/sec	Conc,mg/l
10	5.298E-01	1.9683-0.6561	2.3
20	3.454E-01	0.6561-0.2187	10.7
30	2.425E-01	0.2187-0.0729	16.6
40	1.781E-01	0.0729-0.0243	9.5
50	1.350E-01	0.0243-0.0081	0.0
60	1.048E-01	0.0081-0.0027	0.0
70	8.278E-02	0.0027-0.0009	0.0
80	6.639E-02	0.0009-0.0003	0.0
90	5.391E-02	Total classes	39.0

Range 8, Center of Channel, 1200 hours

Sal=25.0 ppt Conc= 105 mg/l Stl Height= 0.85 m
Avg= 0.442 mm/sec Mn= 0.188 mm/sec
Std Dev= 4.5 Skew.= 0.00 Kort.= 0.32

	Cumulative	Differential	
% >	Setl Vel,mm/sec	Setl Vel,mm/sec	Conc,mg/l
10	1.098E+00	1.9683-0.6561	22.7
20	7.051E-01	0.6561-0.2187	26.1
30	4.530E-01	0.2187-0.0729	26.2
40	2.913E-01	0.0729-0.0243	26.4
50	1.874E-01	0.0243-0.0081	3.6
60	1.207E-01	0.0081-0.0027	0.0
70	7.783E-02	0.0027-0.0009	0.0
80	5.021E-02	0.0009-0.0003	0.0
90	3.242E-02	Total classes	105.0

(Continued)

(Sheet 2 of 3)

Table F1 (Concluded)

Range 10, Center of Channel, 1350 hours

Sal= 2.0 ppt Conc= 40 mg/l Stl Height= 0.85 m
Avg= 0.449 mm/sec Mn= 0.171 mm/sec
Std Dev= 5.4 Skew.=-0.03 Kort.= 0.33

% >	Cumulative Setl Vel,mm/sec	Differential Setl Vel,mm/sec	Conc,mg/l
10	1.209E+00	1.9683-0.6561	9.3
20	7.616E-01	0.6561-0.2187	9.2
30	4.760E-01	0.2187-0.0729	8.8
40	2.949E-01	0.0729-0.0243	8.4
50	1.810E-01	0.0243-0.0081	4.4
60	1.100E-01	0.0081-0.0027	0.0
70	6.616E-02	0.0027-0.0009	0.0
80	3.935E-02	0.0009-0.0003	0.0
90	2.312E-02	Total classes	40.0

Range 12, Center of Channel, 0818 hours

Sal= 0.0 ppt Conc= 18 mg/l Stl Height= 0.85 m
Avg= 0.351 mm/sec Mn= 0.139 mm/sec
Std Dev= 5.1 Skew.= 0.19 Kort.= 0.45

% >	Cumulative Setl Vel,mm/sec	Differential Setl Vel,mm/sec	Conc,mg/l
10	1.199E+00	1.9683-0.6561	3.1
20	5.303E-01	0.6561-0.2187	3.1
30	2.818E-01	0.2187-0.0729	4.2
40	1.650E-01	0.0729-0.0243	5.3
50	1.029E-01	0.0243-0.0081	2.3
60	6.707E-02	0.0081-0.0027	0.0
70	4.524E-02	0.0027-0.0009	0.0
80	3.135E-02	0.0009-0.0003	0.0
90	2.221E-02	Total classes	18.0

(Sheet 3 of 3)